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THE INVESTIGATION OF THE SAN FRANCISCO EARTHQUAKE

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U. S. GEOLOGICAL SURVEY [1]

IT is the natural and legitimate ambition of a properly constituted geologist to see a glacier, witness an eruption and feel an earthquake. The glacier is always ready, awaiting his visit; the eruption has a course to run, and alacrity only is needed to catch its more important phases; but the earthquake, unheralded and brief, may elude him through his entire lifetime. It had been my fortune to experience only a single weak tremor, and I had, moreover, been tantalized by narrowly missing the great Inyo earthquake of 1872 and the Alaska earthquake of 1899. When, therefore, I was awakened in Berkeley on the eighteenth of April last by a tumult of motions and noises, it was with unalloyed pleasure that I became aware that a vigorous earthquake was in progress. The creaking of the building, which has a heavy frame of redwood, and the rattling of various articles of furniture so occupied my attention that I did not fully differentiate the noises peculiar to the earthquake itself. The motions I was able to analyze more successfully, perceiving that, while they had many directions, the dominant factor was a swaying in the north-south direction, which caused me to roll slightly as I lay with my head toward the east. Afterward I found a suspended electric lamp swinging in the north-south direction, and observed that water had been splashed southward from a pitcher. These notes of direction were of little value, however, except as showing control by the structure of the building, for in another part of the same building the east-west motion was dominant.

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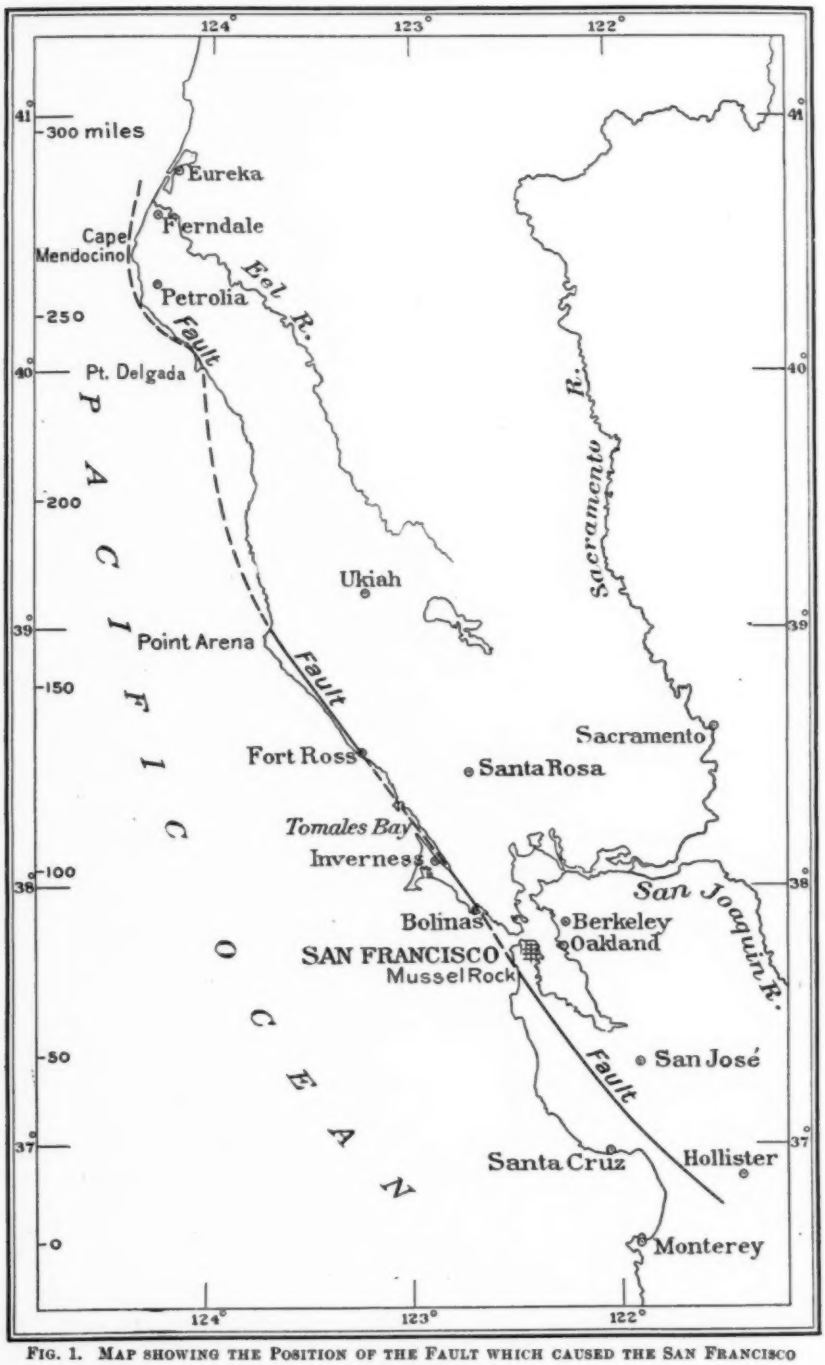

FIG. 1. MAP SHOWING THE POSITION OF THE FAULT WHICH CAUSED THE SAN FRANCISCO EARTHQUAKE.

In my immediate vicinity the destructive effects were trivial, and I did not learn until two hours later that a great disaster had been wrought on the opposite side of the bay and that San Francisco was in flames. This information at once incited a tour of observation, and thus began, so far as I was personally concerned, the investigation of the earthquake. A similar beginning was doubtless made by every other geologist in the state, and the initial work of observation and record was individual and without concert. But organization soon followed, and by the end of the second day it is probable that twenty men were working in cooperation under the leadership of Professor J. C. Branner, of Stanford University, and Professor A. C. Lawson, of the State University at Berkeley. At that time and for several succeeding days the ordinary means of communication were so paralyzed or overburdened that no messages passed between these two centers of organization; but as the needs of the hour were patent to all, the work was not prejudiced by the lack of intercommunication.

On the third day after the shock Governor Pardee appointed a State Earthquake Investigation Commission, naming as its chairman the head of the geological department of the State University, Professor Lawson, and including in its membership Professor Branner, of the Stanford University, Professors Davidson and Leuschner, of the State University, Professor Campbell, of the Lick Observatory, Mr. Burckhalter, of the Chabot Observatory, Professor Reid, of Johns Hopkins University and Mr. Gilbert, of the United States Geological Survey. The commission held its first meeting three days later, when the scope of its work was considered and defined, provision was made for circulars soliciting information, an announcement was prepared for the purpose of relieving certain groundless fears entertained by a portion of the community, and two committees were appointed for the general work of observation. To the first committee, with Professor Lawson as chairman, was assigned the determination and study of surface changes associated with the earthquake and the collection of data as to intensity, so that isoseismals, or curves of equal intensity, might be drawn upon the map. To the second committee, with Professor Leuschner as chairman, was assigned the collection of data for the drawing of coseismals, or lines connecting points on the earth's surface reached by the shock at the same instant. Some weeks afterward, when the main features of the earthquake had become known, a third committee was appointed, with Professor Reid as chairman, to consider the relations of the earthquake phenomena to certain problems in geophysics, or the science of the inner earth.

The work of these three committees is still in progress, and will not be completed for several months. The actual drawing of isoseismals and coseismals can not be performed until a large body of obser-

vations have been compiled and studied, and the geophysical problems are as yet only imperfectly formulated; but of the physiographic phenomena, or the disturbances of the earth's surface, so much is known that it has been thought advisable to prepare a preliminary report. This was submitted to the governor on the third of June, and has been issued as a pamphlet of twenty pages. The expenses of the commission are being met by the Carnegie Institution.

Architects and engineers were not less prompt and energetic. To

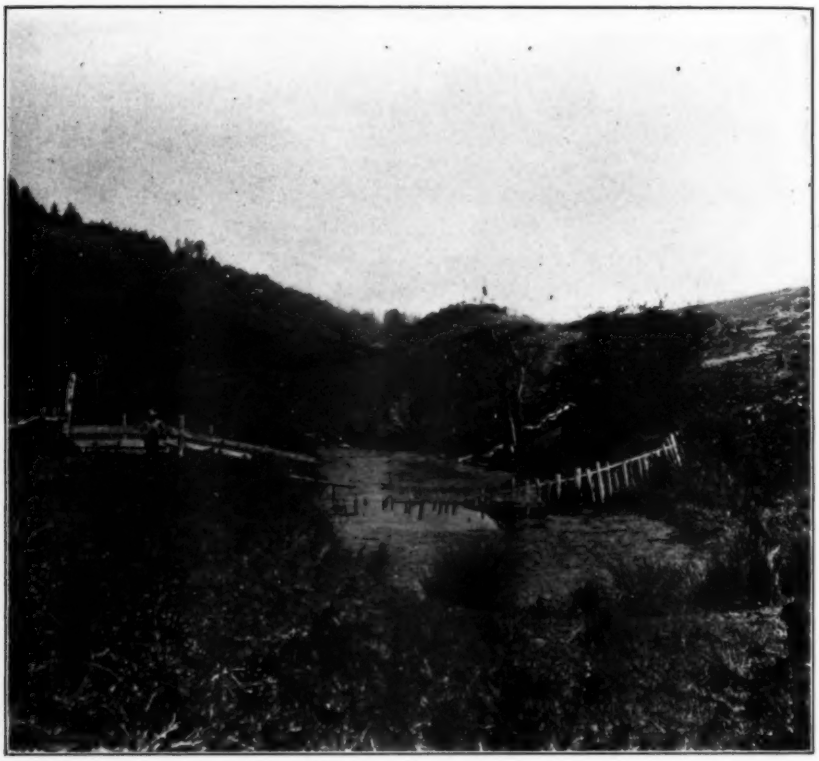

FIG. 2. FAULT TOPOGRAPHY BETWEEN TOMALES AND BOLINAS BAYS; looking northwest. The general slope toward the left has been interrupted by a slight uplift of the part at the left. The pond occupies a hollow thus produced.

the men who plan and direct construction in the earthquake district of California it was important to know what materials and what structural forms best withstood the shock, and they immediately began the study of earthquake injuries and of instances of immunity from earthquake effects. In that part of San Francisco where the earthquake injury was most serious the shock was quickly followed by fire, which destroyed much of the evidence, but many important observations were made in the brief interval. The study of structural questions, like the

study of natural phenomena, was at first individual only, but afterward was aided by organization. Committees were appointed by various professional societies, national and local, and were charged with the investigation of specific structural questions, and the results of their labors will find place not only in the transactions of the societies, but in revised building regulations and in important modifications of municipal plants for lighting and water supply. Various bureaus of the national government have also taken part in the structural studies, sending experts to San Francisco and other localities of exceptional earthquake violence.

The Japanese government promptly sent to California a committee of investigation headed by Dr. Omori, professor of seismology in the University of Tokyo, and composed otherwise of architects and engineers. The first conference of these visitors with the state commission warranted the suggestion that we may find it as profitable to follow Japanese initiative in the matter of earthquake-resisting construction as in that of army hygiene.

The following sketch of the physical features of the earthquake is based chiefly on the body of data gathered by the State Commission:

An earthquake is a jar occasioned by some violent rupture. Sometimes the rupture results from an explosion, but more commonly from the sudden breaking of rock under strain. The strain may be caused by the rising of lava in a volcano or by the forces that make mountain ranges and continents. The San Francisco earthquake of April 18 had its origin in a rupture associated with mountain-making forces. A rupture of this sort may be a mere pulling apart of the rocks so as to make a crack, but examples of that simple type are comparatively rare. The great majority of instances include not only the making of a crack but the relative movement or sliding of the rock masses on the two sides of the crack; that is to say, instead of a mere fracture there is a geologic fault. After a fault has been made its walls slowly become cemented or welded together, but for a long time it remains a plane of weakness, so that subsequent strains are apt to be relieved by renewed slipping on the same plane of rupture, and hundreds of earthquakes may thus originate in the same place. From the point of view of the geologist the displacements of rock masses are the primary and important phenomena; the faults are incidental phenomena, of great value as indices of the displacements; and the earthquakes are of the nature of symptoms, serving to direct attention to the fact that the great earth forces have not ceased to act.

A faulting may occur far beneath the surface and be known only by the resulting earthquake; but some of the quake-causing ruptures extend to the surface and thus become visible. The New Madrid and Charleston earthquakes are examples of those having deep-seated

origins, the Inyo and San Francisco of those whose causative faults reached the surface of the ground.

The general character of California earthquakes was so well known that when the dispatches told of a severe shock at San Francisco no American geologist had a moment's doubt that it was caused by a fault movement, and among those specially conversant with the structure of the affected district attention was immediately directed to several fault lines, with the expectation that one or more of them would show the marks of fresh dislocation. Mr. Ransome prepared a prophetic article

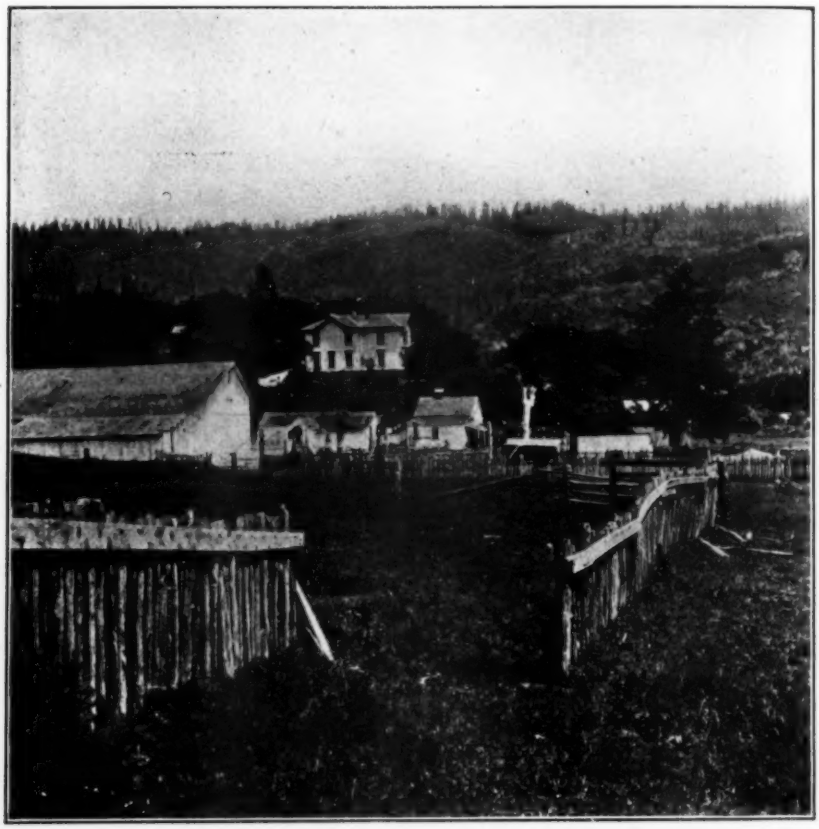

FIG. 3. THIS FENCE, PREVIOUSLY CONTINUOUS AND STRAIGHT, was broken and parted by the earthquake fault, the offset being 8½ feet. The line of fault, concealed by the grass, crosses the ground from left to right, touching both the dissevered ends of the fence.

in which he indicated the lines most likely to be concerned.[2] Professor Branner stated in an interview that he had immediately made a forecast of the locality of the origin and that it had proved to be correct, and Mr. Fairbanks went at once to a zone of 'earthquake topography' with which he was already acquainted, and found a fresh rupture in the expected place.

[2] *Nat. Geog. Mag.*, Vol. 17, 1906, pp. 280–296.

The San Francisco earthquake was caused by a new slipping on the plane of an old fault which had been recognized for a long distance in California, and in one place had been named the San Andreas fault. Associated with this fault is a belt of peculiar topography, differing from the ordinary topographic expression of the country in that many of its features are directly due to dislocation, instead of being the product of erosion by rains and streams. One of its characteristics is the frequent occurrence of long lines of very straight cliffs. Another is the frequent occurrence of ponds or lakes in straight rows. The tendency of erosion is to break up such cliffs into series of spurs and valleys and to obliterate the lakes by cutting down their outlets or filling their basins with sediment. Fig. 2 shows one of the fault-made ponds. This line and zone have been recognized by California geologists through a distance of several hundred miles. It was to this line that attention and expectation were especially directed, and it was on this line that the surface evidence of new faulting was actually found. The new movement was not coextensive with the line as previously traced, but affected only the northwestern portion; and, on the other hand, it extended farther to the northwest and north than the old line had previously been recognized. The accompanying map represents only the line along which the recent change occurred. From a point a few miles southwest of Hollister it runs northwestward in a series of valleys between low mountain ridges to the Mussel Rock, ten miles south of the Golden Gate. Thence northwestward and northward it follows the general coast line, alternately traversing land and water. The farthest point as yet definitely located is at Point Delgada, but the intensity of the shock at the towns of Petrolia and Ferndale probably indicates the close proximity of the fault and warrants the statement that its full length is not less than three hundred miles. South of Point Arena its course is direct, with only gentle flexure, but the data farther north seem to imply either branching or strong inflexion. Opposite San Francisco its position is several miles west of the coast line, and it nowhere touches a large town.

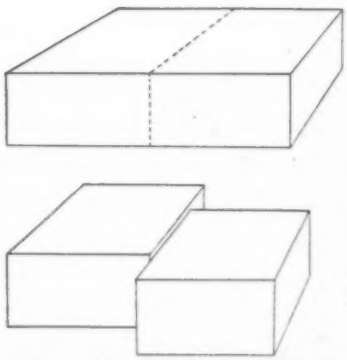

FIG. 4. DIAGRAMS ILLUSTRATING THE DISLOCATION CAUSING THE SAN FRANCISCO EARTHQUAKE. The upper represents an earth block 100 feet square and 25 feet thick, with indication of the position of the fracture. The lower shows the relation of its two parts after faulting.

That which occurred along this line was a differential movement and permanent displacement of the rock and earth on the two sides of a

vertical crack. The principal displacement was not vertical, but horizontal. If one thinks of the land to the east of the crack as stationary, then the change may be described as a northward movement of the land west of the crack. If the land to the west be thought of as stationary then the land to the eastward moved toward the south. It is probable that both tracts shared in the movement, the eastern shifting toward the south and the western toward the north. Perhaps the nature of the change can be more readily understood by reference to Fig. 4, which represents an ideal block of the earth's crust, 100 feet square on the surface and 25 feet deep, before and after its division and dislocation by the earthquake-causing fault.

Wherever a fence, road, row of trees, or other artificial feature following a straight line was intersected by the fault its separated parts were offset, and an opportunity thus afforded for measuring the amount of change. The measurements range in the main from 6 to 15

FIG. 5. A FAULTED ROAD NEAR THE HEAD OF TOMALES BAY. The nearer and more distant parts of the road were originally in one line—a continuous, straight road. The present offset is twenty feet.

feet and have an average of about 10 feet. At one place (Fig. 5) a road was offset 20 feet, but in this case the underlying ground was wet alluvium and part of its movement may have been due to a flowing of the soft material. There was also some vertical change, but this was not everywhere in the same direction and its amount was comparatively small. At many points the land west of the fault appears to have risen one or two feet as compared with the land at the east.

FIG. 6. ORDINARY APPEARANCE OF THE EARTHQUAKE RIFT WHERE IT TRAVERSES FIRM TURF.

The surface manifestation is not usually a simple crack, but a disturbed zone a few feet broad, the earth within the zone being split into blocks which show more or less twisting or rotation. In some places the zone is slightly depressed below the adjoining surfaces, and elsewhere slightly elevated. Other disturbances of the surface were associated with the earthquake, but the track of the central fault has a character of its own, a character with which the field workers soon became familiar, so that it could be clearly identified. It came to be distinguished in their conversation and note-books as 'the rift.' For considerable distances the rift is single, but elsewhere it is more or less divided, the parts lying within a few rods of one another and being approximately parallel. There are also branches parting from the main rift at various angles and gradually dying out in the adjacent country, and in some of these the belt of disturbance is broad and complicated (Fig. 7). There are also outlying cracks occurring within a mile or two of the central rift and having irregular courses, and these may probably be referred to the same general system of rock strains.

Other cracks are distinctly secondary in character; that is to say, they are not due directly to the stresses and strains by which the fault was made, but are results of the earthquake itself. The jar constituting the earthquake, or in technical language the earthquake wave, as it travels through rock and earth produces temporary compressions and other strains, and these often occasion cracks at the surface. Where the material is elastic such secondary cracks merely open and close, leaving the ground with its original form; but where it is inelastic and incoherent, as in the case of young alluvial formations and artificial

fillings, some of the cracks opened by passing waves do not close again, but remain as permanent vestiges of the shock. Closely associated with these secondary cracks in soft ground are permanent changes in surface form. At the head of Tomales Bay, for example, a broad tract of soft ground between high and low tide was thrown into low ridges, with cracks along their crests, and these remained until destroyed by wind waves. In San Francisco considerable tracts of 'filled' land were shaken together and thus made to settle a few feet, and were at the same time slidden several feet toward the bay (Fig. 9).

Certain changes, very conspicuous to the observer who drove about the country, are closely associated with roads. A side-hill road is

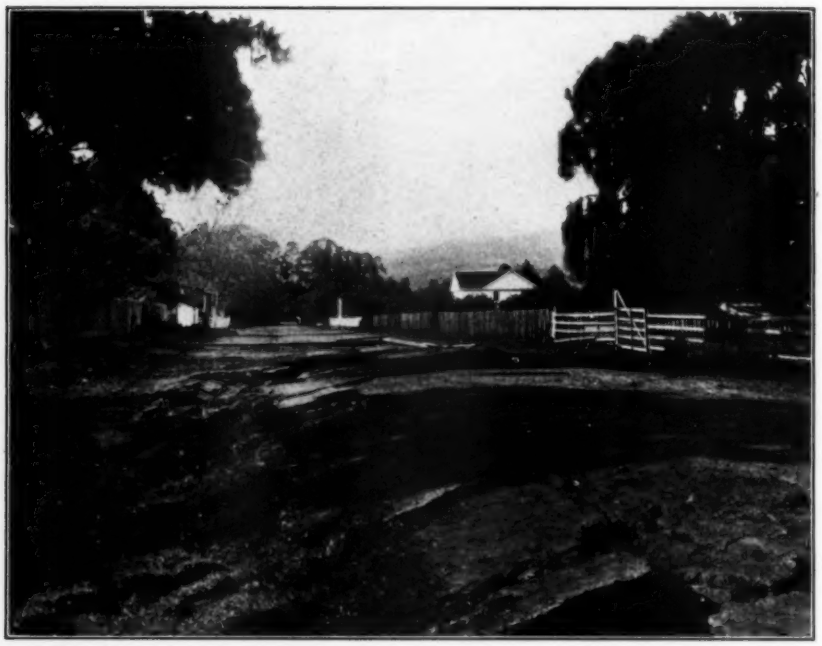

FIG. 7. A ZONE OF EARTHQUAKE FRACTURE WHERE IT CROSSES A ROAD NEAR BOLINAS.

usually constructed by excavating a notch in the natural slope and piling the excavated material in an embankment at the outer edge of the notch. In course of time, and especially during rainy seasons, the embankment at the outer edge of such a road settles and has to be built up as a matter of repair. Portions of the bluff on the up-hill side of the notch are also apt to fall away, taking the form of small landslides, which have to be removed from the road as a rule after every rainy season. The earthquake precipitated many changes of this sort. Along all side-hill roads in the immediate vicinity of the rift a crack was developed between the embankment and the original soil against which

it rested, and this crack often assumed formidable dimensions (Fig. 10); in fact its magnitude was found to be a convenient index of the local violence of the earthquake in regions where buildings are rare. Landslips from the bluffs margining the roads (Fig. 11) were also very numerous, in many instances stopping traffic until repairs could be made. And there were many landslides on a larger scale, the earthquake initiating movements which might otherwise have been delayed for years or even centuries. Some of these landslides fell into streams, dammed their waters and created temporary lakes.

FIG. 8. CRACKS CAUSED BY THE SHAKING OF MARSHY GROUND. The comparatively firm road embankment preserved the cracks better than the bog.

Other disturbances of water supply were more directly connected with the earthquake. At several points large volumes of water were squeezed from the ground during the agitation, causing brief but violent torrents, and one of these brought with it so much sand as to constitute a sort of sand eruption. There are reports also that certain springs have received a permanent increase in volume, a result which would naturally follow from the modification of underground circulation by the cracking of rock and earth.

Wherever the shock was specially strong there was considerable injury to trees; some were overturned, others broken near the ground, and yet others broken near their tops. A number of large redwood trees standing on the line of the rift were split from the ground upward, the basal portions being faulted along with the ground they stood on.

In the systematic survey of the earthquake area the relative intensity is being estimated by means of the records of various physical

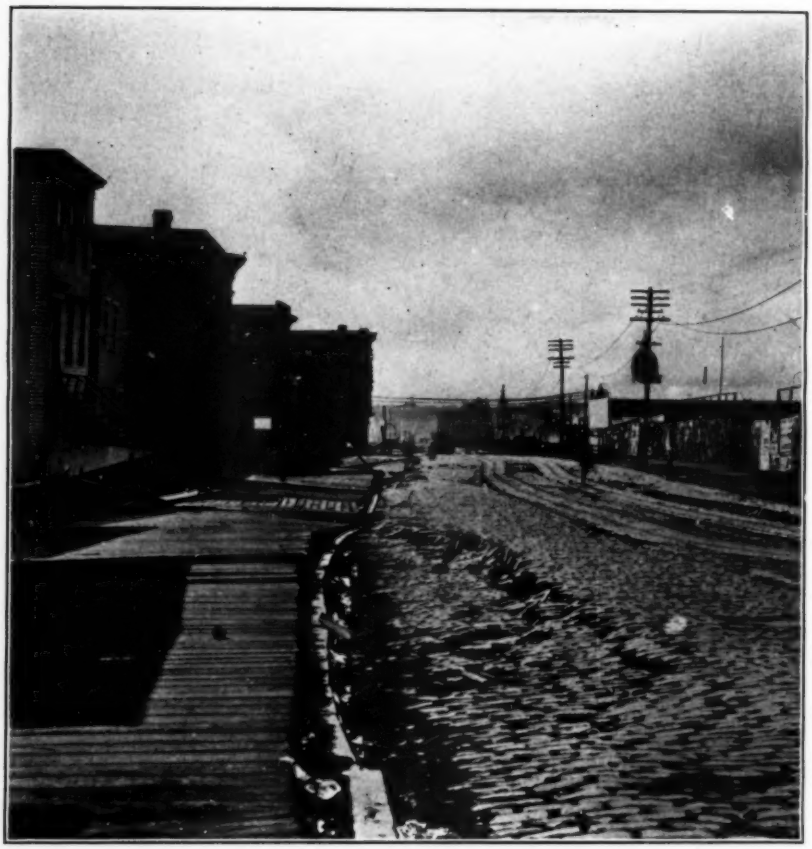

FIG. 9. STREET SCENE IN SAN FRANCISCO, showing effect of the earthquake on filled ground. The distant p rt of the street probably retains its original level and position. Nearer by the ground has settled several feet and has also moved to the left.

effects. In the immediate vicinity of the fault road-cracks and cracks in alluvium are large and numerous; many trees were broken or overturned; there were many landslides; half of the wooden buildings of any village or hamlet were shifted horizontally, often with serious injury; buildings and chimneys of brick or stone were thrown down;

during the shock men, cows, and horses found it impossible to stand, and fell to the ground; and some persons were even thrown from their beds. In a general way all these evidences of violence diminish gradually with distance from the fault on either side. The rate of diminution, with exceptions to be mentioned presently, may be expressed by saying that at five miles from the fault only a few men and animals were shaken from their feet, only a few wooden houses were moved from their foundations, about half the brick chimneys remained sound and in condition for use, sound trees were not broken, and no cracks were opened which did not immediately close. At a distance of twenty miles only an occasional chimney was overturned, the walls of some brick buildings were cracked, and wooden buildings escaped without injury; the ground was not cracked, landslides were rare, and not all sleepers were wakened. At seventy-five miles the shock was observed by nearly all persons awake at the time, but there were no destructive effects; and at two hundred miles it was perceived by only a few persons.

FIG. 10. ROAD CRACK CAUSED BY THE EARTHQUAKE.

FIG. 11. SMALL LANDSLIDE ON THE UPHILL SIDE OF A SIDE-HILL ROAD.

A number of exceptions to this gradation of intensity are connected with tracts of deep alluvial soil, especially if saturated with water, and with tracts of 'made ground.' The great destruction in the low-lying part of San Francisco, eight miles from the fault, is directly connected with the fact that much of the ground there is artificial, the area having been reclaimed from the bay by filling in with sand and other materials. The severity of the disaster at San José, twelve miles from the fault, has been ascribed to the deep alluvial soil on which the town stands, and many other local peculiarities seem to admit of the same explanation. It is necessary also to distinguish carefully between earthquake intensity and destructive effect, because injury to property was conditioned by mode and material of construction no less than by intensity of vibration. But after making due allowance for differences in natural foundation and for differences in the resisting power of buildings, there remain various anomalies for which satisfactory explanation has not as yet been found. The natural foundation of Oakland is similar to that of San José, and its distance from the earthquake

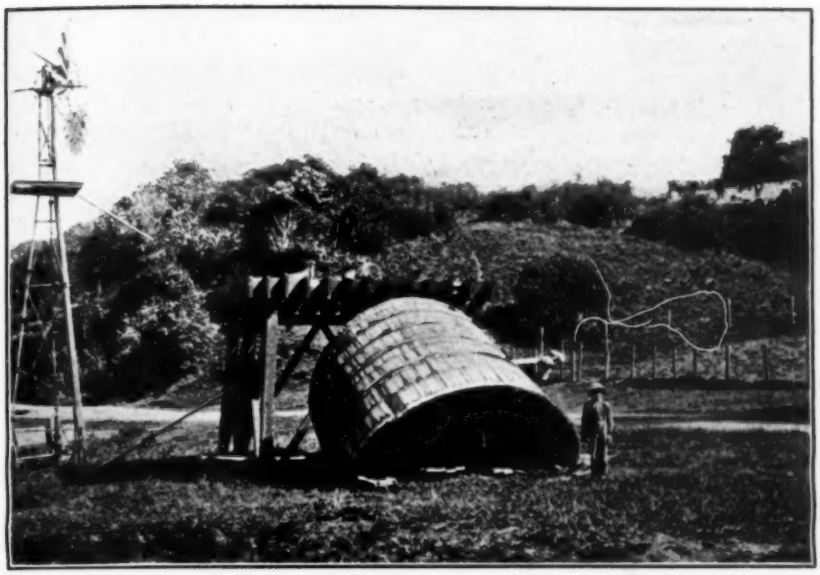

FIG. 12. WATER TANK THROWN FROM ITS PEDESTAL BY THE EARTHQUAKE.

FIG. 13. SCHOOL-HOUSE AT POINT REYES STATION, NEAR INVERNESS; shifted horizontally two and one-half feet by the earthquake. The corner here shown was slipped from the foundation and rests directly on the ground.

origin is about the same, but the injury to its buildings was decidedly less; and Santa Rosa, standing on ground apparently firmer than that at Oakland or San José and having a somewhat greater distance from the fault, was nevertheless shaken with extreme violence.

It is too early to discuss these anomalies. With the data now in hand it seems to be true that there are outlying tracts of high intensity surrounded by areas of relatively low intensity; and these features, if they shall be fully established, will doubtless affect in some important way the general theory of the earthquake.

One of the chief uses of time observations in connection with most earthquakes has been to determine the position of the origin. As the elastic wave travels outward in all directions from the initial point it reaches successively points on the earth's surface which are more and more remote. Coseismal lines, or lines of simultaneous arrival, are, therefore, closed curves circling about the region of the initial fracture. In the case of the San Francisco earthquake this particular function of the coseismals is not required, because the fracture is visible at the surface; but they are not therefore without value. It is not to be supposed that the yielding of the earth occurred at the same instant throughout the entire extent of the fault plane. We should assume, rather, that the fracture, beginning at some point, was extended thence to the remainder of the tract, a certain amount of time being consumed in its propagation. When the time data have been collected and studied, it may be possible to determine at what point the fracture began and at what rate it was extended. It is hoped also that when the time records and intensity records shall have been systematically discussed there may result some conclusion as to the depth to which the fault extended and also as to its subterranean form.

Mention has already been made of the question whether the permanent dislocation or change of absolute position involved in the faulting was divided between the tracts of land on the two sides or was confined to one or the other of them. At first sight it would appear that the only thing susceptible of actual determination is the relative displacement, and that the absolute displacement, or the real movement with reference to the earth as a whole, must remain a matter of theory only. Nevertheless, it happens that in this particular instance the real changes in geographic position are not only susceptible of determination, but are actually to be investigated. To illustrate the problem, let XY represent, in ground plan, a portion of the fault line, and let $ABB'C$ be the original position of a straight line intersected by the fault. Assuming for the moment that the dislocation was equal on the two sides of the fault, then the line AB was carried to the position DE, and the line $B'C$ to the position FG. We may think of the distances BE and $B'F$ as each equal to five feet. The dislocation of five

feet pertains to every point near the fault line, but it is not supposable that the same dislocation affects points at a great distance from the fault. At some remote point, for example Z, in the direction $B'C$, there was no displacement. If $B'C$ and FG were both produced in that direction they would be found not precisely parallel, but would eventually coalesce. How far the undisturbed region Z may be from the fault line is a matter of pure conjecture, but we may plausibly assume that the transverse dimension of the area affected by the displacement is of the same order of magnitude as the length of the fault line and is measured by hundreds of miles. If this assumption is correct, then throughout a great region in central and northern California all points have experienced a change in geographic position, the change in the vicinity of the fault being of about five feet and the amount diminishing toward the northeast and southwest. If the only determinations of latitude and longitude within this area were of the ordinary approximate character, it would be impossible to measure the changes in geographic position theoretically accomplished by the fault; but it fortunately happens that the region is traversed by two belts of the triangulation of the United States Coast and Geodetic Survey, one being a system of triangles for the control of the coastal map work, and the other the elaborately measured transcontinental belt. The region thus contains several scores of points whose coordinates have been determined with a high degree of precision, and it is possible by the redetermination of these positions to measure the dislocations which have taken place in connection with the earthquake. As all topographic and hydrographic maps of California are dependent for their latitudes and longitudes upon the positions given by this triangulation, and as there is reason to believe that many of these positions have been disturbed by a measurable amount, the superintendent of the Coast Survey has determined to repeat so much of the work of triangulation as may be necessary in order to redetermine the geographic positions. And it is proposed to carry this work far enough eastward to connect the redetermined points with stations that may safely be regarded as quite beyond the effect of the recent fault. When this has been accomplished much light will be thrown on the nature and distribution of the strains which were relieved by the dislocation along the fault line, and it will

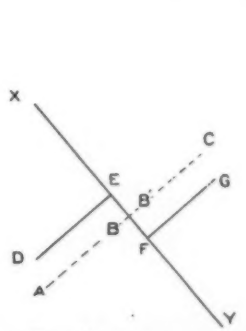

FIG. 14. DIAGRAMMATIC PLAN OF A PORTION OF THE EARTHQUAKE FAULT, illustrating changes in geographic position.

be possible to say definitely whether the original displacement involved the territory on both sides of the fault or on one side only.

A further check is to be afforded through the observations for astronomic latitude at Ukiah. The observatory at Ukiah is between 25 and 30 miles in a direct line northeast of the fault. In connection with the general dislocation it was presumably moved toward the southeast and its latitude diminished by several hundredths of a second. This is one of an international series of observatories established in approximately the same latitude but in different longitudes, for the purpose of determining variations in the position of the earth's axis of rotation. If the observations at Ukiah were studied alone it might not be possible to separate the result of a small change in the observatory's position from the effects of the migration of the axis; but by combining the Ukiah data with those furnished by the other observatories of the system, it is probable that the effects of the two causes can be discriminated.

The most important practical results of the various earthquake studies will probably be afforded by the engineers and architects, and will lead to the construction of safer buildings in all parts of the country specially liable to earthquakes; but the geologic studies of the State Commission are not devoid of economic bearings. In the city of San Francisco and adjacent parts of the peninsula on which it stands the underlying formations include several distinct types, and the district is so generally occupied by buildings that the relations of the several formations to earthquake injury can readily be studied. Such a study is being made with care and thoroughness, and one of its results will be a map of the city showing the relation of the isoseismals, or lines marking grades of intensity, to tracts of solid rock, to tracts of dune sand in its natural position, to upland hollows partially filled by grading, and to old swamps, lagoons and tidal marshes that have been converted into dry land by extensive artificial deposits. The information contained in such a map should guide the reconstruction and future expansion of the city, not by determining the avoidance of unfavorable sites, but by showing in what areas exceptional precautions are needed, and what areas demand only ordinary precautions.

Another economic subject to which the commission may be expected to give attention is what might be called the earthquake outlook. Must the citizens of San Francisco and the bay district face the danger of experiencing within a few generations a shock equal to or even greater than the one to which they have just been subjected? Or have they earned by their recent calamity a long immunity from violent disturbance? If these questions could be answered in an authoritative way, or if a forecast could be made with a fair degree of probability, much good might result; and even if nothing more shall be possible

than a cautious discussion of the data, I believe such a discussion should be undertaken and published. Of snap judgments there has been no lack, and the California press has catered to a natural desire of the commercial public for an optimistic view; but no opinion has yet been fortified by an adequate statement of the pertinent facts. Among these facts are the distribution of earthquake shocks as to locality, time and severity in California, and also in the well-studied earthquake district of Japan; the relation of the slipping that has just occurred to the geologic structure of the coast region; the relation of other fault lines to the bay district; and the relation of the recent shock to a destructive shock that occurred in 1868. If a broad and candid review of the facts shall give warrant for a forecast of practical immunity, the deep-rooted anxiety of the community will find therein a measure of relief. If a forecast of immunity shall not be warranted, the public should have the benefit of that information, to the end that it shall fully heed the counsel of those who maintain that the new city should be earthquake-proof. In any case, timidity will cause some to remove from the shaken district and will deter others who were contemplating immigration; but such considerations have only temporary influence and can not check in an important way the growth of the city. The destiny of San Francisco depends on the capacity and security of its harbor, on the wealth of the country behind it, and on its geographic relation to the commerce of the Pacific. Whatever the earthquake danger may be, it is a thing to be dealt with on the ground by skillful engineering, not avoided by flight; and the proper basis for all protective measures is the fullest possible information as to the extent and character of the danger.

SEISMOGRAPH AND MAGNETOGRAPH RECORDS OF THE SAN FRANCISCO EARTHQUAKE, APRIL 18, 1906[1]

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THE San Francisco earthquake was one of several large earthquakes recorded the world over since the beginning of this year. The writer's prime interest in it as a magnetician is in the record it left behind on the magnetographs at various magnetic observatories of the United States Coast and Geodetic Survey.

It has happened several times within the last few years that earthquakes have occurred in this country which were not recorded for one reason or another, on the existing seismographs, but were indicated by the record of certain magnetographs. The most notable instance was the New England earthquake of March 21, 1904, at about eight minutes after one o'clock in the morning, eastern time. Seismographs of the Milne type at Toronto, Canada, and Baltimore, Maryland, and of the Bosch-Omori type at the Weather Bureau, Washington, D. C., failed to give any record of this earthquake, which was appreciably felt throughout the New England States. The magnetograph at the observatory, Cheltenham, Maryland, sixteen miles southeast of Washington, gave a distinct record at $1^h\ 05^s$ to $1^h\ 17^m$ eastern time. So there have been a number of earthquakes recorded by the magnetograph at Baldwin, Kansas, which were felt in the middle states and reported in the papers. In fact, at this observatory, situated in a region where felt and unfelt local and regional earthquakes are comparatively frequent—note for example the many recent occurrences—more records of earthquakes are obtained on the magnetograph than at any of the other magnetic observatories.

This repeatedly authenticated fact made desirable a concurrent study of seismograph and magnetograph records and hence seismographs have been installed within the last two years at all of the magnetic observatories excepting at Baldwin, Kansas, which was omitted because of its probable early removal on account of the possibility of disturbing influences from electric-car lines. So it happens that the Coast and Geodetic Survey is able at present to contribute the principal portion of the accurate observational data of earthquakes obtained in this country. It was with the expectation that magnetic observatories would also be excellent stations for the installation of

seismological instruments that the writer, while attending the Seventh International Geographic Congress at Berlin, 1899, as a delegate from the National Geographic Society, was made a member of the Provisional Committee of the International Seismological Association, just organized by the congress.

The instrumental seismological data referring to the recent San Francisco earthquake will be contributed from the following stations in Canada and the United States:

TABLE 1. LIST OF STATIONS AND INSTITUTIONS IN CANADA AND THE UNITED STATES CONTRIBUTING SEISMOLOGICAL DATA.

Station.	Institution.	Seismograph.	Magnetograph.
Toronto.	Meteorological Service.	Milne.	Adie.
Victoria.	" "	"	.....
Albany.	State Geological Survey.	Bosch-Omori.	.....
Baltimore.	Johns Hopkins University.	Milne.	.....
Washington.	U. S. Weather Bureau.	Bosch-Omori.	.....
Cheltenham.	U. S. Coast and Geodetic Survey.	" "	Adie and Eschenhagen.
Vieques.	" " " " "	" "	Eschenhagen.
Baldwin.	" " " " "	.....[1]	"
Sitka.	" " " " "	Bosch-Omori.	Eschenhagen.
Honolulu.	" " " " "	Milne.	"
Berkeley.	University of California.	Ewing.	.....
Mt. Hamilton.	Lick Observatory, U. of C.	"	.....
Manila.	Philippine Weather Bureau.	Vicentini.	Mascart.

The exceedingly sparse distribution of seismological stations in this country is made apparent by this list, there being none in the middle portion of the United States, where, as already stated, regional earthquakes are comparatively frequent. It is therefore fortunate in the study of the San Francisco earthquake that we may have recourse also to the data afforded by magnetographs, especially by those at Baldwin, Kansas, and Sitka, Alaska—the nearest magnetic observatories to the origin of the quake and situated, as will be seen from Table 3, at about the same distance from San Francisco. So also is it a fortunate circumstance that we have both magnetograph and seismograph data from the two magnetic observatories, Honolulu and Cheltenham, which are also practically equidistant from the origin.

Now a peculiar circumstance is that this earthquake, while giving a record on the seismograph at the Porto Rico Magnetic Observatory so large as not to be fully recorded, left no trace behind on a magnetograph of the very same pattern as at the other observatories. On the

[1] A Bosch-Omori seismograph procured for this observatory was temporarily installed at Baltimore by Professor H. F. Reid for a comparative study with his Milne seismograph.

other hand, the equally large earthquake of January 31, last, the origin of which was at sea off the west coast of Ecuador, besides recording itself on seismographs the world over was recorded on the magnetographs at Baldwin, Porto Rico and Cheltenham, but this time not at Honolulu. This seaquake was accompanied by a tidal wave twenty feet high which rushed in on the coast of Ecuador, causing great devastation; it set the Pacific Ocean in vibration, which according to the tide-gauge records of the Coast and Geodetic Survey at San Diego and Honolulu lasted for three days. The tidal wave, when it rushed in on the Hawaiian coasts, was several feet high, and the record of this quake of January 31, as recorded on the Milne seismograph at the Honolulu Magnetic Observatory, was among the largest since the installation of the instrument, September, 1903, and yet the delicately suspended magnets, as far as the magnetic records at this observatory would indicate, were not affected.

Why is it that an earthquake will at times be recorded by magnetic instruments and at other times leave no record? Or, to go back to the fundamental question, what do the magnetic instruments record—an actual mechanical effect due to the mechanical vibration of the point of support? If the observed effect is a purely mechanical one, then why is it that not every mechanical disturbance is recorded on the photographic records of the fluctuations of the magnetic needles? What is the characteristic of the mechanical vibration, the presence or absence of which in the earth movements is responsible for the presence or absence of the effect recorded by magnetic needles?

The solution of these questions may show the magnetograph to be a most useful adjunct to the present instrumental equipment for recording earth movements.

Is the possibility of any actual magnetic effect accompanying an earthquake entirely to be excluded? If so, in the case of the distant earthquakes, as seems probable, is the possibility also to be excluded for the less distant ones, or say for stations within a certain prescribed region about the origin of the quake? Are those cases where records are secured on magnetographs and not on seismographs to be attributed possibly to such a magnetic effect which has no influence on instruments responding merely to mechanical vibration? Or is it possible that the magnetograph is in certain cases a better micro-seismograph than the Milne or Bosch-Omori instruments used in this country?

We have thus some extremely interesting questions presented to us which, however they may be solved, will be a valuable contribution to our knowledge of earth movements. The possibility might also be mentioned that an approaching earthquake might through electric or magnetic effects give the first indication on magnetographs because of the much greater velocity of propagation of such effects than that

of the mechanical vibrations. We know that a magnet subjected to strain undergoes changes in its magnetization and so the question arises whether the earth's magnetized rocks may not likewise give some indication of their state of strain during an earthquake by slight magnetic fluctuations. Or, an earthquake may be accompanied by a redistribution of the magnetic rocks or of the electric earth-currents known to exist, and thus give rise to a possible magnetic effect.

Enough has been said to show that a careful and exhaustive investigation of seismic effects recorded on magnetographs is certainly one that merits undertaking. The Department of Terrestrial Magnetism of the Carnegie Institution of Washington, in connection with the study of the magnetic effect recorded simultaneously over the entire globe coincident with the outbreak of Mt. Pelé, on May 8, 1902, is making a systematic study of the volcanic and seismic effects recorded by magnetic instruments with the cooperation of the Coast and Geodetic Survey and of the Canadian Meteorological Service. A paper by Mr. J. E. Burbank, published in Vol. X., p. 113, of the journal, *Terrestrial Magnetism,* brought the investigation up to the time of the installation of the seismographs at the Coast and Geodetic Survey Observatories two to three years ago; a second paper, to be published in the course of the year, will continue the research as based upon seismic and magnetic instruments in operation at the same observatory.

It had been noticed for some time that magnetic instruments responded to certain earthquakes, but the cases noted were of such a class as to convey the first impression at once that the effects recorded were mechanical ones. Milne in 1898 made quite an exhaustive investigation of this class of effects for the whole earth and covering the period from 1889 to 1897. He likewise found that these effects were not invariably recorded at every magnetic observatory. He considered the results inconclusive and deemed it necessary to await the time when both seismograph and magnetograph records could be had at the same place. A recent notable contribution to the subject based on magnetic records at one observatory, without, however, at the same time corresponding seismological data, has been made by Dr. Messerschmitt, in charge of the Munich Magnetic Observatory.

Previous magneticians, such as Eschenhagen, Wild and Liznar, had found that from a comparison of the effects recorded on magnetographs at various European observatories the effects, in certain notable earthquakes, progressed from station to station with the velocity of about three kilometers *i. e.* the rate of propagation of the long or surface seismic waves. This measurable difference in time between any two stations and its correspondence with the time interval required for the transmission of the surface waves was a very good indication that a purely mechanical effect had been recorded and not a distant magnetic

effect, as the latter would have been observed simultaneously at all stations. Or, if it was a magnetic effect, then in each case it was due to one of the possible local causes enumerated brought into action upon the arrival of the mechanical disturbance at the particular station.

In our study, however, it has been possible to differentiate much more closely and at times to separate the effects on the magnetic records into the various phases—preliminary tremors and principal portions, etc.—in a manner analogous to usual treatment of the seismograph records. A notable instance was the destructive Guatemalan earthquake of April 19, 1902, which, as may be recalled, preceded the Antillean volcanic eruptions of that period. At that time there were no seismographs at the Coast and Geodetic Survey Magnetic Observatories; however, an inspection of the table below will show that with the records obtained on the magnetographs at Cheltenham, Baldwin, Sitka and Honolulu (the Porto Rico Observatory did not then exist), it is possible to study the seismic effects on them—even down to the preliminary tremors—equally as well as on the seismic records obtained at Baltimore, Toronto and Victoria. The earliest notice of this earthquake was received at Baldwin, the nearest station to the origin—Guatemala. Here then we have a notable case where the magnets were affected by even the preliminary seismic tremors, this being a different case from the European ones cited above, as these tremors travel with a velocity of about nine kilometers or more per second.

There have been many other similar instances and it has even occurred at times that the magnetic instruments have given a slightly

TABLE 2. SEISMOGRAPH AND MAGNETOGRAPH RECORDS OF THE GUATEMALA EARTHQUAKE, APRIL 18, 1902.

Station.	Latitude North.	Longitude W. of Gr.	Greenwich Mean Time. Preliminary Tremors Begin.	Long Waves Begin.	Time of Maximum.	End of Effect.	Instrument.	Component or Magnetic Element.
	° ′	° ′	h m	h m	h m	h m		
Baltimore.	39 18	76 37	2 30.1	2 35.6	2 40.3	5 30	Milne seismograph.	N. W.
Cheltenham.	38 44	76 50	2 30.4	.....	2 31.0	2 57	Eschenhagen magnetograph.	Hor. In.
"	" "	" "	2 30.4	.....	2 31.6	2 55	" "	Decl'n.
"	" "	" "	2 33.2	2 36.7	2 40.5	2 59	Adie "	Hor. In.
"	" "	" "	2 29.0	2 35.1	2 48.4	3 00	" "	Vert.In.
"	" "	" "	2 29.0	2 40.7	2 42.3	2 58	" "	Decl'n.
Toronto.	43 40	79 23	2 30.5	2 35.5	2 38.0	5 24	Milne seismograph.	East.
Baldwin.	38 47	95 10	2 24.6	2 30.0	2 34.6	2 57	Eschenhagen magnetograph.	Hor. In.
"	" "	" "	2 29.1	2 31.2	2 34.8	2 53	" "	Decl'n.
Victoria.	48 27	123 22	2 31.3	2 37.2	2 50.7	5 36	Milne seismograph.	East.
Sitka.	57 03	135 20	2 40.4	.....	2 59.6	3 05	Eschenhagen magnetograph.	Hor. In.
"	" "	" "	2 36.8(?)	.....	.....	2 49	" "	Decl'n.
Honolulu.	21 19	158 04	2 31.3	.....	.....	2 39	" "	Hor. In.
"	" "	" "	2 31.8	.....	.....	2 35	" "	Decl'n.

earlier record than the seismograph. The effect is such a characteristic one that when it has once been recognized it will not be mistaken for any ordinary magnetic effect. Four types can be distinguished: First, those in which the disturbance begins abruptly and quickly reaches a maximum, dying down gradually (usually the case in a near-by earthquake); second, those in which a small preliminary effect precedes the principal portion, and in which there are often two or more maxima; third—by far the most common—those consisting of a small diamond-shaped disturbance; and fourth, those in which the trace is simply blurred and broadened.

With these introductory statements as to the possible relation between seismology and terrestrial magnetism, let us now pass to the consideration of the recent San Francisco earthquake.

Table 3 contains the results of the records obtained up to date (May 17) at the office of the Coast and Geodetic Survey, both from magnetographs and from seismographs. It will be seen that the region embraced extends from Honolulu on the west to Hungary on the east, or about one third the way around the globe. All necessary data, such as latitude, longitude, distances from San Francisco along the surface, as well as along chord, chord depth, etc., etc., are found in the table.

Next are given the Greenwich mean times (0 to 24 hours, midnight to midnight) of the occurrence of the various phases of the seismic disturbance as recorded on the seismographs. For the preliminary tremors, phase I (longitudinal waves), next phase II (transverse waves), then principal portion (surface waves), etc., etc. It is particularly interesting to compare the times for Cheltenham, Washington and Baltimore and to note how closely they agree. Owing to the slight difference in distance of these three different stations from San Francisco the times should not of course be strictly the same, though the difference should not be more than a few seconds. Considering the totally different types of instrument (Milne at Baltimore and Bosch-Omori at Washington and Cheltenham), certainly the comparison is very satisfactory.

It will be seen that the preliminary tremors were recorded by the seismographs at Honolulu and Cheltenham at about the same time, these two stations being at about the same distance from San Francisco. The reader will follow without assistance the progression of the various waves from station to station as given in the table. [Since this table was prepared many more records have been obtained which are of interest, notably the seismograph and the magnetograph records from the Toronto Magnetic Observatory.]

In Fig. 1 we have a reproduction of the seismograph record obtained at the Cheltenham Magnetic Observatory. The recording cylinder of the Bosch-Omori seismograph, around which is wrapped the

San Francisco Earthquake, April 18, 1906. Results of Seismograph and Magnetograph Records.

Place—Country.	Honolulu, T. H.	Sitka, Alaska.	Baldwin, Kansas.	Cheltenham, Maryland.	Vieques, Porto Rico.	Birmingham, England.	Göttingen, Germany.	Ogyalla Hungary.	Zagreb Croatia.	Washington, D. C.	Baltimore, Maryland.
Latitude (North)	21°19′ N.	57°03′N.	38°47′N.	38°44′N.	18°09′N.	52°30′N.	51°32′N.	47°52′N.	45°49′N.	38°54′N.	39°18′N.
Longitude from Greenwich	153 04 W.	135 20 W.	95 10 W.	76 50 W.	65 26 W.	1 54 W.	9 57 E.	18 52 E.	15 59 E.	77 03 W.	76 37 W.
Great Cir. Distance in Degrees	34.8	21.1	21.3	35.4	53.1	76.0	81.4	87.6	88.4		
" " " " Miles	2407	1455	1473	2447	3670	5251	5627	6056	6109		
" " " " Kiloms	3874	2342	2371	3938	5906	8451	9056	9746	9831		
Chord Distance in Miles	2371	1447	1465	2409	3541	4876	5167	5484	5522		
" " " " Kiloms	3816	2329	2358	3877	5699	7847	8315	8826	8887		
Greatest Chord Depth in Miles	181	67	68	188	418	839	959	1103	1121		
" " " " Kiloms	291	108	109	303	673	1350	1543	1775	1804		
Earthquake (Seismograph)	Greenwich Mean Time 0-24 hours. First shock at San Francisco $13^h\ 12^m$ Gr. M.T.										
Preliminary Tremors I	$13^h19.5^m$ s	$13^h17^m01^s$	h m s	$13^h19^m24^s$	$13^h22^m17^s$	$13^h25^m03^s$	$13^h24^m32^s$	$13^h25^m20^s$	$13^h25^m25^s$	$13^h19^m20^s$	$13^h19^m24^s$
" " II	13 25.8 ?	13 21 01?	.....	13 25 04	13 29 55	13 35 07	13 34 42	13 36 08	13 35 32	13 25	13 25 12
Principal Portion; Begins	13 27.9	13 23 ?	.....	13 30 13	13 41 29	13 45 13	13 51	13 53 38	13 53 16	13 30	13 31 36
" " Max	13 32.9	13 25 off	.....	13 35 ?	13 50	.....	13 53	14 00	14 01	13 32	13
" "	.....	off	.....	.....	.....	.....	13 57	14 06		13 35 off	
" " Ends	.....	.....	.....	13 44							
End of First Shock	.....	16 55	.....	16 35 N. 17 07 E.	16 12 N. 16 27 E.	15 29	19	.....	.....	17 35	
Earthquake (Magnetograph)											
Begins	13 27.8	13 22.9	13 24	13 30	None						
Ends	13 37(D) 13 42(H) 15 07(Z)	13 31.9	13 31	14 04							
	Velocity of Seismic Waves in Miles or Kilometers per Second.										
Seismograph. Long. Waves, P.T. I	5.3 miles	4.8	.....	5.4	5.7	6.2	6.9	6.8	6.9	along chord.	
	8.5 kms.	7.7	.....	8.7	9.2	10.0	11.1	11.0	11.0		
Trans. Waves, P.T. II	2.9 miles	2.7	.....	3.1	3.3	3.7	4.0	4.0	4.1	" medium path.	
	4.6 kms.	4.4	.....	5.0	5.4	5.9	6.3	6.4	6.6		
Surface Waves, P.P	2.5 miles	2.2	.....	2.2	2.1	2.6	2.4	2.4	2.5	" surface.	
	4.1 kms.	3.5	.....	3.6	3.3	4.2	3.9	3.9	3.6		
Magneto-graph Surface Waves, P.P	2.5 miles	2.2	2.5	2.2							
	4.1 kms.	3.5	3.9	3.6							

smoked sheet of paper on which the record is made, makes one complete revolution in an hour, each sheet whether of the N.–S. or of the E.–W. component containing a whole day's record (24 lines). The distance between two of the dots represents one minute. In order to get a convenient size for the figure, it was necessary to omit about one third of the total length of the sheet, so that the distance from S. to S. or E. to E. represents about two thirds of an hour. On the original, the pointer or the recording stylus multiplies the motion ten times, hence in the reproduction the magnification is about three times. The maximum amplitude of motion was not recorded, the pointer striking the damping brushes. In deducing the actual displacement of an earth-particle at Cheltenham, it is necessary to take into account the period of the pendulum which for the N.–S. component was about 25 seconds and for the E.–W. component about 20 seconds and the period of the recorded earth-movement about 2 to 4 seconds for the preliminary tremors and about 10 to 20 seconds for the principal portion. A rough calculation would give the total recorded horizontal displacement of the earth-particle, back and forth, of about 1/5 of an inch, which on account of the comparatively long period would not be felt by the human being. These explanations will doubtless be sufficient for the elucidation of the figure; for a description of the instrument the reader is referred to Dutton: 'Earthquakes.'

Passing next to the times recorded by the magnetograph (*D* stands for declination, *H* for horizontal intensity and *Z* for vertical intensity), it is seen that the effect in this instance did not begin at the four observatories where a record was obtained—Honolulu, Sitka, Baldwin and Cheltenham—until the arrival of the principal portion (long or surface waves) recorded on the seismographs, and that for this phase the agreement between seismograph and magnetograph is most satisfactory. It will also be noted that the time at Baldwin is intermediate between San Francisco and Cheltenham, so that the record of this observatory is a most desirable acquisition. Note also that the time is nearly the same as at Sitka, Baldwin being just a trifle farther from San Francisco than Sitka.

Next are found in the table the velocities of the various transverse waves—longitudinal, transverse and surface—computed along the paths indicated in the column on the extreme right. For the region embraced it will be seen that the longitudinal waves, which were the first to arrive, traveled at an average velocity of six miles per second, the transverse waves at an average velocity of 3½ miles, whereas the surface waves had a velocity of about 2 1/3 miles per second according to seismograph and magnetograph. It takes about 3 hours and 20 minutes for these waves to pass around the earth completely, whereas the preliminary tremors, phase I (longitudinal waves) reach

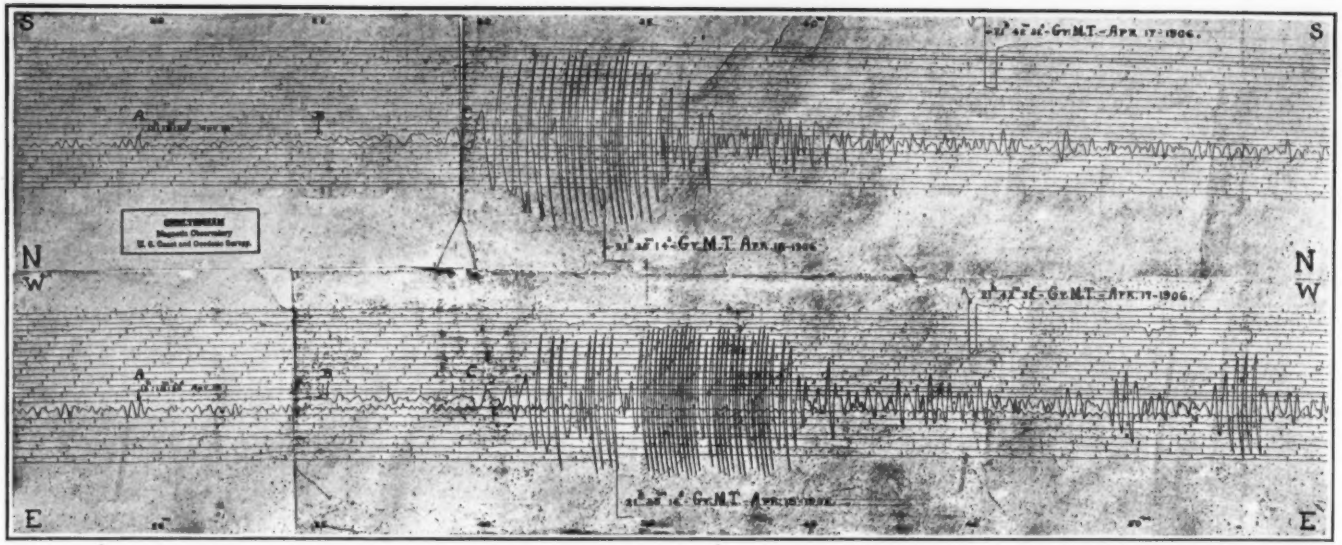

FIG. 1. RECORD OF THE SAN FRANCISCO EARTHQUAKE, AS OBTAINED ON THE BOSCH-OMORI SEISMOGRAPH at the Magnetic Observatory, Cheltenham, Maryland, reduced three and one-half times. [The records of the N–S component and of the E–W component were re-arranged so as to bring the points of beginning of the preliminary tremors, phase I (A) in the same vertical line. B marks the beginning of the preliminary tremors, phase II and C the beginning of the long or surface waves.]

a point on the opposite side of the earth from the origin in about 20 minutes; the latter are supposed to pass directly through the earth. In computing the velocities I have taken provisionally as the average

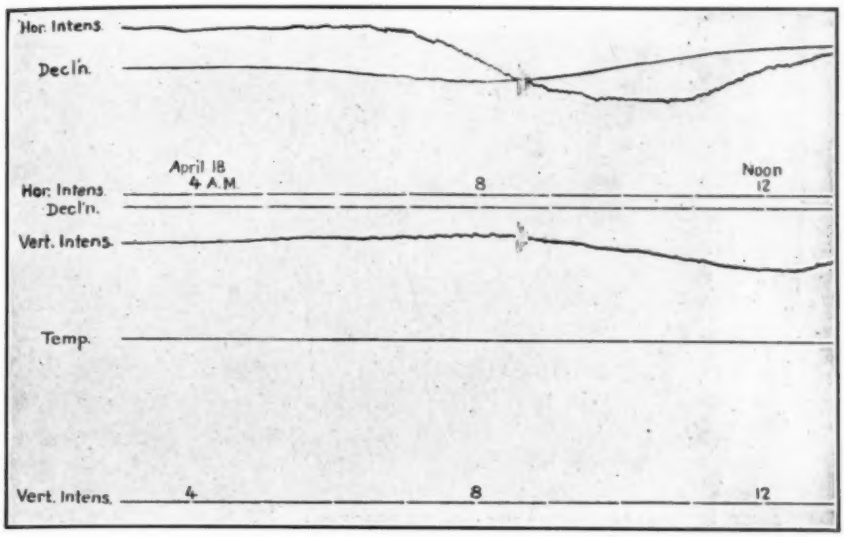

FIG. 2. RECORD OF THE SAN FRANCISCO EARTHQUAKE ON THE ESCHENHAGEN MAGNETOGRAPH at the Magnetic Observatory, Cheltenham, Maryland, reduced 2 times. [The hours as marked are approximately local mean time. The earthquake effect will be noticed on the three magnetic elements, horizontal intensity, declination and vertical intensity in the shape of a trumpet formation between 8 and 9 a. m., local mean time. The range or double amplitude of the disturbance was about 1/1000 part of the horizontal intensity and about 1/3000 part of the vertical intensity. On account of the intersecting of the curves, the range in the magnetic declination cannot be given.]

time of the shocks on the Pacific Coast which gave rise to the effects recorded at distant places as occurring at $5^h\ 12^m$ Pacific time or $13^h\ 12^m$, April 18, Greenwich time. There may have been earlier preliminary shocks.[2]

[2] *Professor George Davidson*, of the University of California, determined the time of first shock at his home in San Francisco by counting the number of seconds it took him upon awakening and going to his watch and noting the time. Owing to his large experience in the work of the U. S. Coast and Geodetic Survey, the time which he gives he deems to be correct within two seconds, *viz.*, 5: 12: 00 Pacific time.

Professor A. O. Leuschner, of the University of California, according to his article in the *Berkeley Reporter*, of Berkeley, Cal., April 20, 1906, says: "The best record of the beginning of the heaviest shocks is furnished by the standard clock of the Student Observatory, which stopped at $5^h\ 12^m\ 38^s$ Pacific standard time, while less severe shocks were recorded by Mr. S. Albrecht some 35 seconds earlier. The principal part of the earthquake came in two sections, the first series of vibrations lasting about 40 seconds. The vibration diminished considerably during the following 10 seconds and then continued with renewed vigor for about 25 seconds more. But even at this writing, about noon, the disturbance has not as yet subsided, as slight shocks are being recorded at frequent intervals on the Ewing seismograph, which has been restored to working order. [This seismograph was thrown out of action at the beginning of the earthquake; however, a fairly complete record was obtained with the duplex instrument.] The principal direction of motion was from south-southeast to

The amplification of this table to embrace the entire earth will be left to Professor Harry F. Reid, a member of the San Francisco Earthquake Commission.

Why is it that in this severe earthquake the magnets responded only to the long or surface waves and not to the preliminary tremors, and why did the magnets at Porto Rico give no record at all? These are the questions which I believe to be of concern not alone to the magnetician, but also to the seismologist and to the student of geophysics in general. Of the many earthquake records already obtained, there are a large number where the disturbance on the seismograph was considerably smaller than the San Francisco one and yet the magnetograph responded to even the preliminary effects. Evidently we must be getting a record of something on the magnetograph, not immediately evident from the present seismograph records, which causes this peculiar differentiation of seismic disturbances into the following classes: (*a*) recorded by seismograph and not by the most delicate magnetograph, (*b*) recorded by magnetograph and not recorded by seismograph, (*c*) recorded by seismographs and magnetographs partially (surface waves), (*d*) recorded completely by seismographs and magnetographs.

My present belief is that the effects recorded by suspended magnets are chiefly mechanical ones due to the vibrating motion of the points of support, though the possibility of a magnetic effect within a certain prescribed region of the origin of the earthquake, brought about as above explained, is not to be excluded. It is a notable fact that at the Baldwin Magnetic Observatory, where, as stated, so many seismic effects are being detected which are to be associated with the comparatively local earthquakes in the Middle States and which fail to make any record on seismographs as far distant as Washington, the effects corresponding in time to lightning discharges have also been found which in many instances resemble very closely the seismic effects.

In the case of the San Francisco earthquake, however, there can apparently be no question that what was recorded by the magnetographs was a mechanical effect (see Fig. 2). It is a matter of interest to note

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north-northwest. The remarkable feature of this earthquake aside from its intensity was its rotary motion. The sum total of all displacements represents a very regular ellipse and some of the lines representing the earth's motion can be traced along the whole circumference." From this we deduce the time of the first shock 5:12:03.

At the Lick Observatory the first shock was recorded at 5:12:12.

At the Ukiah Latitude Observatory the first shock was recorded according to Dr. Townley at 5:13, correct within two or three seconds.

At Eureka, California, the first shock as reported to Professor Davidson was noted on a regulator owned by H. H. Buhne, who was awake at the time at 5:11.

As it is likely that the epicenter was somewhat west of San Francisco, but at no considerable distance, owing to absence of tidal waves, it is probable that the average time of the shocks at the origin which produced the records at the distant observatories was not far from $13^h\ 12^m$, Greenwich mean time, which is at present adopted. L. A. B.

that at Baldwin there was a slight actual magnetic effect 3–4 hours before the shock was felt at San Francisco, to which no counterpart has yet been found on the Cheltenham records, indicating that this effect observed at Baldwin was not a cosmic one, but was due to some local circumstances. To associate it with the San Francisco earthquake is not at present warranted.

Owing to the optical arrangement of the magnetograph, in order to produce an effect which will be evident on the recording sheet, it is necessary to have a *turning* movement of the suspended magnet. Any parallel displacement of the magnet—sidewise or up and down—will give no observable effect, an actual turning or rotary movement of the magnet must take place and for this purpose a turning couple must in some manner be introduced. Such a couple is produced when the magnet is drawn out of its normal direction with the aid of a bit of iron which is then quickly removed; the earth immediately acts on the magnet with equal and opposite forces applied near the extremities, and after performing a number of vibrations about its mean position the magnet settles down and then takes up the course pursued before the artificial disturbance. The effect thus produced is very similar to some of the earthquake effects. Were an earthquake accompanied by the generation of magnetic forces, the explanation of the observed effects would thus be very simple.

When the seismic motion is such as to produce a tilting or rocking of the support, it can readily be shown that because the suspended mass is a magnet, a turning couple is brought into play by the earth's magnetism causing the rotary, vibratory motion of the magnet about its mean position. Were the suspended material a non-magnetic mass of sufficient weight, no such turning would take place, but the mass would act more or less as a 'steady point.' However, it is quite possible that with the very light magnets weighing but ½ gram, and short suspensions used, we may also have to deal with a form of pendulum seismograph, in which the period of the pendulum is sufficiently small as to more readily respond to certain micro-seismic motions than either type of instrument at present in use in this country.

It would seem therefore that seismologists might be assisted in the solution of some of the problems as to the precise character of the earth movements recorded on seismographs by a careful study of the seismic effects recorded on magnetographs, especially if the effects both in the horizontal and in the vertical plane be considered, and if furthermore the record be obtained on a more open time scale, so as to be comparable in this respect with the best seismograms.

Whether the San Francisco earthquake caused a change in the distribution of the earth's magnetism within the affected region is at present under investigation.

REMINISCENCES OF YUKON EXPLORATION, 1865–1868

By WILLIAM HEALEY DALL
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OF the human flood which poured over the Chilkoot crest and inundated the drainage basin of the Yukon in the last years of the nineteenth century, Elizabeth Robins, Joaquin Miller and Jack London have given lurid pictures. The thirst for gold drew miners from every western camp, gamblers from every slum, dreamers from three continents, and human parasites from the whole round world. Ignorant of the climatic conditions, unprepared for the vicissitudes of life in the north, often burdened with preposterous machinery, unsuitable equipment and impossible loads—this motley horde invaded the Yukon territory in quest of fortune. With thousands exhaustion, exposure, disappointment, fear and panic dealt harshly in the end.

The interplay of human passions among those stripped thus of every conventionality offered an unrivaled opportunity to the observer. Greed, fear, suspicion, cruelty and selfishness revealed themselves, on occasion, as vividly as did the contrasted courage, kindliness, self-denial and heroic endurance of the nobler souls. On the just and the unjust, the strong and the weak, the coward and the courageous, indiscriminately, played the natural forces. The soft, white, clogging snow, the stinging cold, the searching wind, the claims of appetite—none might forego.

What with the fight for mere existence, the struggle for a paying location, the fitful gleaming of hope, fear, realization and disappointment, few in all that seething multitude may have had eyes for the beauty, the solemnity, the poetry of that wild north land. For most of them memory would picture the weary monotony of the trail, the buffeting of wind and snow, the penetrating rigor of the cold. These things so bit into their experience that all other impressions would seem trivial. Upon these factors fiction and romance would lean for local color, until, in the course of years, they would become to the average man essentially typical of the Yukon country. Under these conditions it seems possibly worth while, for one of the few who visited the Yukon region in its virgin prime, to put on record some of the impressions which it left upon his memory.

Like most great waterways, the Yukon itself has carved its kingdom out from the rude husk of mother earth. Before man was, its waters

flowed in much their present channels. At times their flood was mighty, comparable only with such streams as Amazon and Nilus. Once its waters reflected the foliage of oak and plane-tree; the fig and the tulip tree flourished on its banks and the heights beyond were dark with forests of Sequoia. Later, its soft alluvial flats trembled under the ponderous tread of the hairy mammoth, while the wild horse grazed upon its verdant savannas. The bison knew its prairieland and the mazama its foothills. With the wane of the Age of Ice the musk-ox sought pasturage upon the Yukon tundra.

Strangely enough, during the height of the great Ice Age when the northeastern part of the continent as well as southern Alaska were buried deep under a continental ice-sheet, the greater part of the Yukon basin remained open to the sun. The traces of the glaciers are plain to see, about its head waters, on the Alaskan mountains to the south and the Yukon mountains to the north, but the terminal moraines are there to show where the deadly creeping of the ice was stayed, far above the present valley. During this time, perhaps, the muddy torrents bore to the river and the sea the alluvium which now composes the vast delta of the Yukon and the submarine flats, covering thousands of square miles, which are the characteristic feature of the eastern half of Bering Sea. With the shrinking of the glacier-sheet vast floods of water were let loose upon the alluvium of the lowlands, gradually shaping the features of the valley, concentrating the metallic contents of the gravels, and hurrying seaward the 'mountain meal' or impalpable white silt of the glacial grist.

From the volcanic craters of the mountain ranges to the south and west fine white ashes on one occasion poured in such volume as to cover the ground with a fleecy blanket, several feet thick, for many hundred square miles. Though covered by later accretions, this continuous layer of white ashes may still be traced for many leagues along the steep bluffs of the right bank of the river where it is under-cut by the current.

As the glaciers receded, the water supply became less profuse, the river settled between its banks, while the flats and prairies were invaded by willow and poplar, birch and spruce. The flora of the north, delicate and abundant, spread over the land, followed by the bee and the butterfly. Singing birds found nesting places, and with them all the small wild things which populate the wilderness, to gather sustenance from seed or berry, or seek refuge from the fox or hawk. And so at last the valley lay complete as first we knew it.

A brave domain, well defended, stretching some two thousand miles. On the north broad tundras hardly divided by low hills from the inviolate Arctic floes where they push upon the low sandy coast. To the northwest a turmoil of mountains, with hardly any game, kept off the explorer; while to the west, before the flatlands of the delta, lay many

miles of mudflats and shifting sandbars, with no landmarks to indicate the channels of which only the salmon knew the secret. No invader, seeking a fairway for his vessel, might find comfort here. On the south the mighty rock walls of the Alaskan and St. Elias ranges, bristling with splintered crags, between which lurk the unconquered remnants of the Glacier Age, confront the would-be intruder. Lastly, on the east, mountains alternate with morasses for hundreds of miles; with streams unnavigable even by canoes, except at the price of hourly portages; tamarack thickets too dense to traverse, standing in bogs too soft to afford foothold, and so populated by black flies and mosquitoes as to be abandoned in summer by all the larger animals. Here a little band of Hudson Bay voyageurs, bent on reaching the great unknown river, some sixty-six years ago, were driven, through desperate starvation, to the last imaginable horror. Not till MacMurray flanked them by descending the Mackenzie far beyond the Arctic circle and forcing the Rat River portage to the waters of the Porcupine, were the eastern defenses of the valley carried by an explorer.

Even then, a quarter of a century should pass before the white man from the east met his fellow from the west, under the Arctic circle, at Fort Yukon, and the whole long river should know the stroke of their paddles and smoke of their camp-fires.

When the whites came they but followed on the trails of the Indian, whose far progenitors, lost in the mists of time, had penetrated to the valley, retreating, as legends tell, from massacre on the south at the hands of stronger tribes; or from starvation on the north, where, beyond the flats of frozen mud, lay only the barren floe. To them the Yukon gave of her caribou and salmon, and among her clustered spruce trees they found a safe refuge. There they prospered and begat other generations, who in the fulness of time came to call themselves Yukonikatana, Men of the Yukon. The ancient feud between Indian and Eskimo kept them from the coasts. Thus in a very emphatic sense the valley of the Yukon was their world.

To enter into the Yukon Valley one must scale its watershed or advance by the stream itself through the delta. The former was more difficult, the latter longer and more monotonous. Creeping along the coast in shallow water, one came finally to a branch where a loaded sloop might enter, and, by hard pulling against the current, finally gain the main channel. After leaving the sea one rowed between steep banks, hour after hour, the traveler seeing nothing but muddy water and scattered driftwood. If, in desperation, one scrambled to the level of the land, one saw on every hand an apparently illimitable plain, broken only far to the southeast by a single summit, the isolated peak of Kusilvak Mountain, blue in the distance.

Over the level surface lay scattered the worn and shattered trunks of

driftwood fibrous with grinding in the ice of the spring freshet and stranded by the falling waters. Here and there were small patches of herbage growing rankly in the day-long sunlight of the boreal spring-time. Everywhere rose the harsh cries of water fowl, hovering over their shallow nests hollowed in the warm sand. Ducks, geese and all the smaller waders, with here and there a sand-hill crane or snowy swan, all busy in the brief domesticity of spring, thronged the flats, covered the pools, or rose in dark extended myriads, as far as the eye can see. Violent cries and flapping wings called attention to some disreputable looking fox, with the rags of his winter coat still hanging to him, prowling in search of eggs of nestlings, but valiantly faced by the mother birds with loud vociferation. Now and then the great Arctic hare, looking as big as a deer in the absence of objects of comparison, lopes silently and swiftly between the tufts of succulent herbage; or a great black raven croaks hoarsely overhead, watching his chance to snap up a downy duckling in the absence of its defenders. The sun, low in the heavens, sheds genial warmth over the noisy congregation, and rich green patches of *Mertensia,* or forget-me-not, open a profusion of blue petals, basking in the radiance. Dotted over the sands little yellow poppies stand singly, spreading silky corollas over their slender densely hispid stems. A profusion of Saxifrage, Potentilla, sedge and Claytonia is found on every hand, except where the latest freshets have been scouring. Steadily between its low steep banks flows the turbid river, dividing into many channels most of which, when the floods are over, become dry.

After days of laborious tracking or rowing the main river may be reached. This for hundreds of miles flows steadily, with its current mainly hugging the right bank. This, if there be any high land about, is high, facing the stream with bold bluffs, which are gradually eaten away at the base by the gnawing current. At intervals a vertical slice of the bluff cracks, quivers and plunges into the water, carrying with it undergrowth and trees, which may remain as dangers to navigation or join the fleet of arboreal derelicts steadily moving toward the sea.

The left bank is usually low, with perhaps a blue line of distant hills dimly visible. Islands in the lower river are not numerous, though many sand-bars come to light at stages of low water. The scour of the river in spate is not favorable to permanent islands.

Ascending the river to the very center of the Alaskan territory, its width is suddenly contracted, its rate of flow increased, while high on either hand the banks rise steep and mountainous. This cañon received from the Hudson Bay men the picturesque name of 'the Ramparts.' Between the June water level and that of July, at the lower end of the cañon, there is a difference of seventy feet, and the maximum is even greater.

About one hundred miles of the river are comprised within the Ramparts, which do not rise as rocky walls, but rather as steep sparsely wooded slopes, formerly beloved of the mountain sheep. Above the Ramparts the river spreads out upon a wide alluvial plain, dividing itself amongst innumerable islands.

Just below the lower end of the cañon enters from the south the Tanana, River of the Mountain Men, a noble tributary. Here lay Nuklukahyet the neutral trading ground for many years.

On the border of Alaska, just above the Arctic Circle, enters the Porcupine River from the northeast, the channel by which MacMurray won his way into the Yukon valley in the early forties. Here the great river bends to the southeast, enters British territory, and carries its navigable waters further nearly five hundred miles. In this stretch its hitherto pellucid waters receive the milky flow of the White River, glacier-fed, which tinges their flood henceforward, to the sea.

The Yukon is the highway of all this land. When the frosts of October lock the streamlets and choke the outlets of the mountain springs, the wide stream is quickly ice-bound. At some points where the swifter current ripples, open water still remains, giving out feathery streaks of mist to the crisp air.

Migratory fishes hurry to the sea. Already the water fowl have departed. The first snow lies feathery soft amongst the seedling willows on the sandbars. The broad sheets of ice on either shore glisten in the enfeebled sunlight, and as the river falls, they sink, creaking and crashing until the early ice of the shallows lies unevenly on the gravelly river-bed. The turbidity of summer lessens and the current flows steely-dark along the open spaces. Sharper grows the cold; the heavy sun relinquishes more and more of its meridian arc. The skies turn gray, and presently comes the snow, steady, silent, soft, incessant, clothing the world.

Deep under the fleecy blanket nestle the little green herbs. The field mouse tunnels the drifts where he may roam unseen and nibble the sweet bark of the young birches. Stately, silent, vigorous, the ptarmigan cock treads pathways amongst the willows, in snow no whiter than his plumage. Here the admiring flock may pluck the spicy buds to their content, heedless of the fowler's snare, and hardly disturbed when the lesser hare, like them snow white, avails himself of their convenient runway.

The red squirrel chirrups in the branches of the spruce, nipping off the loaded cones. Around him chirp the winter redbirds, cheeriest of residents, while in a neighboring poplar the raucous voice of the whisky-jack declares that the world owes him a living. The yellow-headed woodpecker hammers busily away on some decaying alder and from the steep bluff among the rocks comes with solemn repetition the hoarse cry of the raven.

As the sun sinks early to the horizon the owls call to one another and issue from their retreats, whirring softly among the loaded branches. The squirrels are safe in their holes, but let the incautious snowbird beware, lest he be snatched incontinently from his perch. Snake-like the mink in his dark glistening coat winds among the willows by the waterside, on murder bent. The petulant bark of the dogfox is hushed as he too moves with stealthy tread in search of prey. The stars come out, the shadows blacken, hunters and hunted alike are still. Save for the musical twang of splitting ice, now and then, along the river, a measureless silence descends upon the world. As the cold strengthens, in the northern heavens the pale aurora lifts its quivering arch.

The extreme cold is felt always in still weather. As the wind rises, so does the temperature. When sixty-eight below zero of Fahrenheit implies a calm, a rise of thirty-eight degrees is probable as the wind rises. While it does not often snow at this temperature, the wind may carry so much fine loose already-fallen snow along the surface of the open tundra or the river that it has the effect of a blinding snow-storm, against which nor man nor beast may stand. This is the dreaded 'poorga' of the Russian, the 'blizzard' of the western prairies. Here the ignorant gold seeker, ill-clothed, ill-shod, wearing himself out by vain efforts to withstand the forces of nature, often meets his fate. But who has heard of a Yukon Indian perishing in a poorga? The man of the Yukon had adapted his dress, his snowshoes, his tools, his movements, to his surroundings. Like the beasts of the valley, whose skins he wore, he knew how to seek or build a shelter which would shield him from the blast and keep him safe, even if uncomfortable, until the elements wearied of their rage. The humming of the wind in the swaying spruces, the rattle of flying bits of ice or dead branches blown over the crusted snow, the complaining cry of the hawk-owl as his hollow tree quivered under the gusts, all told of the progress of the storm to him brought up to listen to and understand the voices of the wilderness.

And when at last the storm had spent itself, the traveler came forth from his temporary shelter to beat the snow crystals from his garments and look upon a world swept clean of litter, sparkling white under the winter sunbeams. The grouse from her tunnel in the snowdrift, the squirrel from his hollow log, the snowbirds from their retreats beneath the half-buried branches of the spruce, all issued forth upon their daily sustenance intent. The world was a good world, after all, and the singing gale merely a break in its monotony.

Where the tenderfoot, untrained, undisciplined and terrified, found only a demoniac nature striving to overwhelm a shivering victim, those to the manner born might feel a power, a majesty, an unswerving flight, as of the passing of a messenger of God.

As the days grow longer, while the trails harden, the deep snow settles, bearing a solid crust. There is a mildness in the air and in sheltered places little pools form on the ice about midday. The poplar buds are swelling. The raven's nest among the rocks of the bluff is no longer empty. The river ice whitens though it does not yield. Presently the cry of the wild goose is heard, the flocks are returning from the south. The ptarmigan forsakes the willow thickets, and the hare retreats from the edge of the river. They know what the creaking of the ice portends. The native fish-traps in the channel are dismantled, the snow on the beaches disappears. The river ice settles closer to the sand-bars; there is slush on the trail to the water-hole. The little brooks begin to trickle, and form pools where the grayling makes his retreat from the main river. The smaller migrant birds begin to appear, the wheatear, the American robin and a host of others, with phalaropes and sandpipers. The harlequin ducks arrive in pairs, silently making their way up the smaller streams, seeking secluded spots for nesting. The first mosquitoes appear, advance guard of the multitudinous pests of summer.

As the streams increase in volume the river rises, the ice becomes rotten and is lifted from the sand-bars; man and beast seem to wait breathless for the ice to go out. The sun pours down with a fervor not soon forgotten, though in the shade it is always cool.

The cry of the brant, northward bound, is continually heard, and myriads of smaller water fowl appear on every hand. All the minor forms of life, native to the region or migrants from the south, with startling suddenness people the copses and pervade the air. Vegetation springs into leaf and flower at a bound. The water creeps up on the beaches, the ice is shaken by tremors often accompanied by a groaning sound.

The tributary streams begin to run bank-high and flood the surface of the river ice; at last the crisis comes with the upriver rise. The ice breaks, great cakes are driven high upon the beaches or jam in the narrower channels between islands; at last it floods the lowlands; ice, débris, and driftwood pour, with a grinding noise, headlong toward the sea. Below the Ramparts at least a week goes by before the river is free enough from floating ice and broken timber to be navigable, even for canoes. With hardly a hint of spring, summer is upon the valley. Mosquitoes appear in clouds. Except in midstream or where a brisk air is blowing, life without a net and leather gloves is misery. The Indians smear their faces with a mixture of grease and charcoal, and paddle with a smudge on a square of turf, in the bows of their birch canoes. The cribou, moose and bear, driven from the thickets by the clouds of insects, plunge into the river for a temporary respite, where they are often slain by the hunter in his canoe. Whoso must travel

will be prudent to sleep at noon and utilize the cooler hours when the sun sweeps low along the northern horizon and the insects are less active.

As the summer ripens the mosquitoes become less troublesome, though never entirely absent. The strenuous period of the spring floods being over, the great river settles down into its normal summer flow. Early in July it was the ancient custom for the Yukon Men, the Mountain Men from the Tanana River, and sometimes strangers from the Upper Yukon or the Koyukon tributary, to meet on a small flat island where the Tanana and Yukon come together. This was the neutral ground, Nū-klūk-a-yĕt' in the Indian tongue. Here no man might bring his quarrel, no tribe its feud. The meeting was devoted to the peaceful barter of furs, and to festivities where food, the weird Indian music and Indian dances, were the rule.

Many years ago I was fortunate enough to be present at the annual meeting. My companion and myself were the first whites to have that experience. On arrival, after the usual harangue from the senior chief ashore and the spokesman of our party, and several salvos from flintlock muskets ashore and the shot guns afloat, we were allowed to land and a camping ground designated for us by the master of ceremonies, who held his office with dignity.

Later on shouts announced the arrival of the Mountain Men and we hastened to the beach to witness their reception. Dressed in his finest array the senior chief stood at the top of the bank, his followers all arrayed in their best, standing with loaded muskets ready for the salute.

Swiftly around the bend in the river came the little fleet of birch canoes elegantly fashioned, uniform in length and pattern, each holding one man with his bundle of furs and store of provisions. They were uniformly dressed in their purely aboriginal costume of dressed deerskin, ornamented with fringes, quill embroidery, and patterns drawn in red, derived from a soft argillaceous ore of iron. The trousers were continuous with the moccasins, and the upper garment bore a pointed skirt or pendant before and behind. Their long hair tied in two locks at the side of the head, wound with beads and polished with bear's grease, was sprinkled with the chopped up down of swans. Their faces were painted with red ochre, every man wore an ornament piercing the cartilage of the nose, and a belt of dentalium shell or caribou teeth. Their guns lay beside them. With military precision the paddles struck the water in unison, the canoes wheeled and came to rest, paddles uplifted, a short distance from the beach, while every gun on shore boomed its salute. The ceremonies of landing and camping once over, the interest felt in meeting these handsome athletic men, who had never before seen or been seen by whites, was very great. Although

they possessed beads, guns and pipes, these had been acquired from other tribes acting as middlemen. It is probable that people so little touched by our civilization no longer exist in North America. The basin of the Tanana is now occupied by a large mining camp with all that that implies, and the dignity and glory of the Mountain Men have departed.

Midsummer brought all dwellers in the valley to the rivers, that the winter's supply of salmon might be secured, the real staff of life to these people. The banks near the fishing camps were scarlet with long lines of fish, split and cleaned, drying in the sun. On the lower river the salmon were mostly taken in traps. Six hundred miles up-stream only the larger and stronger species made their way. One of my most vivid recollections is of the sight, just after shooting the riffle at the lower Ramparts, of a fishing party provided with very large dip nets on long poles. The dusk was close upon us and the rank of birch canoes, arranged in line transversely to the stream, was already in the shadow of the cañon. Chanting a weird low chant in perfect time, at a given moment the broad nets were simultaneously plunged into the water while the frail birches rocked under the strain. Two canoemen were needed to lift one of the great king salmon out of his native element. The order, precision and silence, except for the mystical chant; the bronzed faces and sinewy arms half disclosed in the waning twilight, the swift water and towering heights of the cañon, left an ineffaceable impression.

The Yukon was good to her children. From her waters came the fish of many sorts, their staff of life. On her broad sloughs and amongst her thickets, the wild geese rested and the ducks raised their downy broods. The furs and skins which kept the native warm and dry, came from her banks. The stately spruce and silvery birch along her shores supplied houses, canoes, utensils, traps and fuel. Floored with ice or flowing yellow in the sun, she was her people's highway. In death their elevated tombs were placed where might be had the widest view of Yukon water.

The Men of the Yukon had, like other men, their careers, affections, tragedies and triumphs. The valley whose rim enclosed their world, since they knew none other, was as wide for them as our world is for us. It is certain that for their world they had worked out problems which we are still facing with puzzled trepidation in ours. No man went hungry in a Yukon village. No youth might wed until he had killed a deer, as token that he could support his family. The trail might be lined with temporary caches, yet no man put out his hand to steal. Men were valued by their achievements and their liberality. Any man might rise to eminence and leadership by showing his fitness in his community. That there were evil doers occasionally is probable,

but there was an unwritten limit which might not be transgressed without condign punishment.

The stranger was welcomed without inquisitiveness, sheltered and fed without ostentation, and sent on his way without fee or reward. The dead were protected and remembered; their deeds of prowess handed down as examples for the young. Debauchery was unknown until taught by men of whiter skins.

They suffered from the dread of mysterious powers, and the shaman took his tithes of them. Their religion was vague and their politics mostly a minus quantity; but in practice they knew what was just and good, and in the main made it their rule of life.

Such were the Men of the Yukon, to whom civilization and the greed of gold brought drink, disease and death. The fittest has survived, but the fittest for what?

Time will restore their verdure to the Yukon placers, when the gold has been extracted and the prospector ceases from troubling. The graceful spruce will clothe her ravaged banks once more, and even the salmon exterminated by the canneries will replenish her waters in the fulness of time. The stern wheeler will pass away with the exhaustion of the mines, or at least become a rarity. The Arctic calm will rest once more upon her hillsides. But the Men of the Yukon trained to her ways by the experience of generations, wise in her capabilities, contented with her bounty, the true children of the river and its valley, these she shall know no more.

FACT AND FABLE IN ANIMAL PSYCHOLOGY

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MAN has ever been ready to show his esteem of animal ways, even to the veneration that in early times took the form of animal worship. The cunning and courage of animals, their passions and endurance, their keenness of sense and mastery of instinct, appealed to the man of nature as enviable qualities. The wolf that he feared, or the horse that be subdued was equally to him a fellow being. He was aware that the animal scent was truer, the animal sense of direction surer, than his own. Matching his wits against theirs, he knew that he might be outwitted by animal wile, might be overcome by animal daring. In his mythology he constructed beings endowed with superhuman qualities by fantastic combinations of the animal and the human form; and in his fables, from Æsop to B'rer Rabbit, he gave to his favorite animal the hero's part in his simple plots. He placed himself under the protection of some sacred animal as a totem, and held it as likely that the souls of an animal could be made to inhabit the bodies of a man; or that by some magic he could be transformed into their semblance.

It is quite possible that some obscure and disguised variety of this same instinctive feeling may still affect our estimates of what animals do, and of how they feel and think. We know so intimately how our domestic pets enter into the routine of our lives, share our moods and occupations, that it seems plausible to suppose that only a lack of speech prevents them from expressing a knowledge of our thoughts and sympathy with our feelings. But when we reflect upon the matter more soberly, we realize that we must not allow our prejudices to affect our judgment of what their behavior justifies us in concluding in regard to their intelligence. In considering what kinds of minds they have and how they use them, we must never forget how different are their needs from ours, how easily an action on their part may seem to be full of meaning to us (because if performed by us it would be done for definite reasons and purposes), and yet may be for them a rather simple trick to gain our favor. This, indeed, is the difficulty of the whole problem. We can judge what animals think only from what they do; yet what they really do may be wholly different from what they apparently do. It is we who unintentionally read into the action the meaning that it has for us. The way out of this difficulty is not very simple nor very direct; and it is the psychologist's business

to determine by all the various kinds of evidence and reasoning that he can bring to bear upon the data, just what kinds of thinking the most favored animal can and can not master. The last particularly must be carefully considered; yet, both for animal capacities and animal limitations, is it of prime importance to note that, like ourselves, animals will only learn to do such things as enter profitably into the scheme of their lives. They will under ordinary natural circumstances acquire an intelligent appreciation of such of the goings on in the world about them as they can put to use; and even though we furnish our pets with decidedly different conditions of life and teach them much that they would have no occasion to learn for themselves, yet the manner of their learning will still remain of the same kind and require the same combination of powers as governs their natural behavior. So, in the end, the question of how animals think is one that psychology may hopefully consider. The answer will never be wholly complete; but there is no reason, so far as it goes, why it should not be sound and convincing—setting forth clearly and precisely what types of intelligent action animals share with us, and how much greater a range of even our simple thinking and doing lies wholly outside of both their interests and their capacities.

Such reflections are brought home to the psychologist whenever he observes how willing people are to be convinced that the multiplication-table and reading and spelling fall as readily within the powers of the exceptional animal as they do within those of an ordinary small boy. Let us consider a group of performances that within recent years have been triumphantly heralded as proving the vast possibilities of animal education, and have been accepted by the vast majority of people for what they pretend to be. A wise horse, 'Kluge Hans,' has mystified Berlin audiences; and 'Jim Key,' another equine sage, has done the same for the American public, by going through a program that includes adding and subtracting, and multiplying and dividing, reading and spelling, telling time and the days of the week, indicating people's ages, or sorting their letters, revealing their professions and their peculiarities, knowing the value of coins and bills, and even pointing out passages from the Bible or reasoning that a circle has no corners! In analyzing such performances, it is indispensable to remain undistracted by what the exhibitor asserts or pretends that the animal does, but calmly to observe what really takes place and to decide not necessarily how the trick is done, but what kind of thinking is concerned in the steps that the animal really takes. Such an exhibition may, however, offer an equally interesting study of the psychology of the audience as of the performer—a study of what people are ready to believe and why they are so disposed.

It does not require a deep psychological insight to make it clear that the calculating and spelling, time-telling and letter-sorting horse

would be as much of a miracle as a Centaur, or a Pegasus, or a Unicorn. All these creatures belong, and with equal obviousness, to the world of fable; and the one falls as far outside the realm of actual psychology as does the other escape the ken of the zoologist. If one is inclined to regard that so obvious a proposition would at once command assent, he need only overhear the talk of those who come away from these 'marvelous' performances to be assured that the calculating horse and the unicorn are in popular estimation horses of very different colors. The latter is at once put aside as belonging to the world of myth; but the former, though not to be met with in every stable, is regarded as falling within the occasional possibilities of mundane horsedom.

If we forget for the moment that there is absolutely nothing in a horse's life that would supply the least occasion for developing so remarkable a talent as is needed for counting or spelling, we may bring ourselves to consider what kind of a miracle the calculating horse would stand for. An extravagant admirer of the Berlin horse, in maintaining that 'Hans's' education is about on a par with that of a boy (even a Berlin boy) of twelve years, has at least the courage of his convictions; nothing less would suffice to fit that genius of a horse to handle numbers and words and the abstract relation of things as his friends allege. And if a Zulu or an Esquimau were, after an equally brief schooling, to turn out a Newton or a Darwin, it would be rather less of a marvel.

To gain a common-sense view of the matter, observe a bright child of three years of age: note how it gives a hundred evidences for every hour of its waking existence, of a ceaselessly busy occupation with all sorts of ideas and little mental problems; how it sets up in its play one situation after another, sees new relations, devises a new use for an old toy, and creates a little world of its own imagining, for which it makes rules and breaks them, pretends that things are happening and gives reasons for their doing so; and so hour after hour proves itself possessed of a very acute little mind to which ideas and relations and situations are very interesting and familiarly handled mental tools or playthings. It is very true that much of this we know only because the child keeps up a constant chatter in its play, and speaks for itself as well as its toy or dolls, reveals its inventions in words, and thus tells the story, which without the explanation we could in our grown-up remoteness from such occupation but feebly understand. But the very possibility of learning all this language and of using it is itself a direct tribute to the intelligence that animates the little brain and reveals its finer quality, its greater possibilities. Language helps, most decidedly helps, the mind to grow in scope and power; but it does not create the capacity which its use requires. We have, moreover, some very interesting accounts of the cleverness of young children, who from early infancy were both deaf and blind, and who from their dark

and silent world into which language could but sparsely enter, gave equally convincing proof of how busy their brains were with much the same kind of thoughts and purposes and interests as make up the mental lives of their more fortunate playmates. Naturally their doings were decidedly hampered, and their thinkings decidedly limited by the slightness of the bond—the single highway of touch—that connected them with their fellow beings. Such a child, in almost as languageless a condition as a dog and with far less chance of finding out what was going on in the world and of participating therein, develops into a rational creature of just that special kind of rationality that even in its simplest terms the brightest dog seems never to achieve.

And now consider what a slow and weary path this bright child, equipped with all its sense and senses, and at the expense of much patient teaching, must tread before it comprehends the message of the letters, and gets to look upon 'twice two is four' as something more than a rather stupid bit of memory exercise, that, like virtue, if persisted in, brings its own reward. With an inconceivably great start beyond the dog or the horse, with a tremendously greater aptitude for just this sort of mental acrobatics, the human child must await some years of ripening of its powers, and upon that favorable foundation expend some further years of initiation and schooling to exhibit a simple proficiency in getting meaning out of those crooked black marks on white paper, and in putting two and two together so as to comprehend the manner of its strange transformation into four. Surely, the accomplishment merits our profound admiration. To this understanding of how much is involved in bringing an apt mind to the point at which reading and calculating becomes a bare possibility, of how great a world is already conquered when the three R's begin to play even the most modest of parts, let us add one point more: When the child begins to show (and not wholly by language) that the letters and numbers have some meaning, it shows the fact so variously that we have constant means of testing how real its knowledge may be. We gain a pretty fair idea in each case, how far the accomplishment is a mere mechanical trick, or a really comprehended operation. Everywhere the limitations are conspicuously obvious; and we know how gradually we must add to the complexity of the business, how readily, by only a slight change in the setting of the problem, we sink the struggling mind beyond its depth. All this is a very sound lesson in psychology to take with us, when we attend a 'show' in which a horse or a dog is put through some steps which are supposed to prove for the star performer a real comprehension of the message of the letters and the operations of the multiplication-table.

With so much of preamble, let us look at the actual performance, first as it is presented on the show-bills, and then as it appears from behind the scenes. The program that advertises the learned perform-

ances of 'Jim Key' includes among its dozen numbers such items as these: 'Jim shows his proficiency in figuring, adding, multiplication, division and subtraction for any number below thirty.' 'He spells any ordinary name asked him.' 'He reads and writes.' 'Gives quotations from the Bible where the horse is mentioned, giving chapter and verse'; and in addition acts as a post-office clerk or handles a cash-register. When these problems are reduced to equine terms, they prove to be simple variations of a single theme. To aid the figuring, the numbers are placed in natural order on large frames, five in a row, and five rows; and the letters, in alphabetical order, are similarly displayed. The numbers to be added or subtracted are proposed by some one in the audience, and repeated by the showman. The horse then proceeds to the card bearing the number that indicates the result, takes that card between his teeth and gives it to his master. The same is done for words composed of letters, each letter being selected in turn.

This is absolutely the whole performance; and even when most generously interpreted bears a decidedly remote resemblance to what the posters describe. The interesting part of it all is that so many who witness this simple exhibition are quite ready to conclude that before 'Jim Key' chooses his card, he goes through those mental processes which each one of the audience performs when he works out the answer to the problem as announced. This assumption is not alone wholly uncalled for, but is actually preposterous. One of the elementary facts that students of mind, whether of human or of animal minds, clearly grasp, is that there are vastly different ways in this complex world of ours, of doing the same thing. The same result is reached by wholly different means. To neglect this distinction would be to conclude that because one man—or, if you like, a horse or a squirrel—avoids a certain mushroom on account of its unpleasant odor, and the botanist does so by recognizing it as a specimen of *Amanita muscaria*, that all have displayed the same kind of intelligence, have used the same reasoning, because in the end they reach the same result—the avoidance of the fungus. To the simple, but comprehensive statement that the horse gives not the slightest indication of going through any of these processes in order to select his card, it need only be added that he gives decided indication of going through a very different kind of process. It is not at all necessary to know precisely what special sign the horse observes in guiding his selections, in order to determine (which is the important thing) that it is some kind of simple sign, an operation that falls within this general type. The type of 'Jim Key's' operation is simply that of learning to go first to a certain one of five rows, that is either the middle, or the top, or the bottom, or the one between middle and top, or the one between middle and bottom; and then in turn to select one of five cards arranged horizontally that offer a similar choice. Whether the cards bear numbers or letters or Chinese

characters or the Weather Bureau signals or any other markings, and whether these markings have any meaning, is as wholly indifferent to the horse as it is unnecessary for him to go through any reasoning process in order to select the card that he is to present as his answer. As to the precise association that an animal comes to establish between a certain sign and a certain action, and the number and complexity of such associations that he can master, there is doubtless some variation among animals, though again hardly as much as amongst men. It is also interesting to determine the nature of the signs, whether noted by the ear or the eye, that a dog or a horse most readily learns; but all these details do not at all modify the general nature of the operation, which mainly needs be considered. The actual indication that 'Jim Key' follows to reach first the right frame, and then the right row, and then the right letter, seems to be given by different positions of the master's whip. The ability to learn even this simple association is probably very limited, and in this case seems never to exceed 'five.' Upon this slender basis of actual achievement, does 'Jim Key' attain his reputation as a learned thinker.

The performances of 'Kluge Hans,' so far as they may be gathered from the printed descriptions, are of no more complex character. The method of response is simpler and consists of nothing more than in pawing continuously one stroke after another, and of stopping when the number of strokes corresponds to the answer of the arithmetical problem that has been set. Alphabets and 'yes' and 'no' must also be reduced to numbers before they fall within 'Hans's' repertory. Here again, as announced, the program is most versatile and startling. There is the same proficiency in multiplying and dividing and adding and spelling; and by an ingenious variation of the question, 'Hans' will tell how many of the admiring company are over fifty years of age, or are members of a certain profession, and will paw 'yes' or 'no' in answer to any question of which his master knows the answer. The claims put forth on behalf of the Berlin horse—and that on the part of men otherwise versed in scientific matters—is indeed remarkable, positively astounding; for one of these attributes to 'Hans' a perfect acquaintance with fractions, the ability of distinguishing colors as well as playing-cards, to tell the coins of the realm, to differentiate geometrical figures, to give the time upon any watch-face, to name musical tones and tell which are discords. The method by which these answers are indicated is never more nor less than that of pawing until the correct number is reached. The more complicated replies are in the form of words: for this purpose the elementary sounds are reduced to 42—allowing for combinations of vowels and consonants. Accordingly, any one of these sounds is indicated by occupying one of *seven* places on one of *six* rows; thus for '*j*,' 'Hans' stamps first *3* times and then *4*; and for '*St*,' first *5*, then *6*. Under this system, the horse

is actually supposed to distinguish between the ordinary '*s*' and the '*long s*' at the end of the word, between '*äu*' (with the Umlaut) and '*au*' without it, and so on. Such, at all events, is the claim set forth for 'Hans's' miraculous intelligence. As a fact it is, of course, completely a matter of indifference to 'Hans' what the questions may be; they could with equal success be put in Greek or Sanskrit, so long as he can catch the right signal and stop pawing at the right time. And so again the gap between fact and fable is world-wide; and the assumption equally groundless that any measure of the human kind of reasoning intervenes to make possible the horse's replies.

Surely there is nothing in either of these performances, except the pretences of the showman, that in the least suggests the use of any of the powers that the developing child must first acquire to gain an actual knowledge of numbers and letters. And, if we look, we shall find many indications of the quite different processes that are really concerned. The best of these lies in the nature of the mistakes that are likely to occur. For 'Jim Key,' these take the form of selecting a neighboring letter—an 'x' for a 'y'—a kind of mistake which no mind that really was doing any spelling would be in the least tempted to commit; while 'Hans's' mistake consists in not seeing the signal quickly enough, and in pawing once too often or in anticipating through the getting ready of the signal, and stopping too soon, again a type of mistake that has no relation to the actual operation of those who calculate and read. So also the scope of the questions that these marvelous animals at once attack without preliminary training shows how unrelated is the finding of the answer to the consideration of the problem. If we add considerably to the difficulty of the problem that we set to a calculating child, we must be prepared to accustom its powers gradually to the increased difficulty and to take small steps repeatedly with much chance for mistake in the newer processes. But these calculating horses jump at once into fractions and square-roots, into propositions in geometry, and equations in algebra, when some enterprising questioner proposes them. This at all events is true for 'Hans's' master, who easily prepares the result; though in 'Jim Key's' case, one sometimes suspects that the calculating possibilities of the master are not immeasurably in advance of those of the horse.

And once more—it certainly seems strange that so exceptionally educated an animal should find no other occasion to exercise his remarkable powers, should not spontaneously exhibit some original evidences of his genius, that would distinguish him from the ordinary horse. We are even tempted to pity so talented an animal with no outlet for its vigorous mind, condemned to the monotonous round of oats and hay, varied only by the tit-bits of carrot and sugar which, however, seem to be appreciated as rewards of learning by these educated animals quite as keenly as by their untutored kind. It is also

pertinent, though possibly unnecessary, to point out the inherent contradiction between the operations that a successful reply is supposed to involve and the absurdity of the failures or wrong answers that occasionally occur. Thus, this most intelligent Berlin horse, who is supposed to be acquainted with difficult mathematical relations, occasionally makes mistakes. Now when a child makes a mistake, it is in regard to some operation just beyond its capacity, while the simpler additions and subtractions are readily accomplished. On the other hand, Hans, immediately after giving an answer in square-root, fails to count the buttons on an officer's coat, and insists, until repeatedly corrected, that a man has three ears and not two; or again, after making the minute distinctions of German orthography, puts *K* for *J;* and further, if this miraculous horse really distinguished the sounds and converted them into letters, why should he not be phonetically misled and occasionally substitute, let us say, a *ck* for a *k,* which would mean all the difference between *2* pawings followed by *1,* and *3* followed by *5.* Yet such objections are indeed superfluous, or would be were they not so commonly disregarded by the prejudice in favor of taking such absurd pretences at their face value. In brief, it is difficult seriously to investigate these limitations in any other spirit than that of pointing out how unmistakably they indicate an unreasoning, unrelated method of reaching the answer through some system of signs.

This statement of the facts of the case does not at all imply that in this performance we have reached the limits of the horse's education. Very likely the intelligent horse may be taught to go very much farther than this in the direction of his natural ability to associate signs with actions. It would, for example, be very interesting to know whether 'Jim Key' could be taught, in selecting one after the other the letters that spell his name, to go of his own accord for the 'I' after he has been led to the 'J,' and then to the 'M,' and so on; that is, whether he could learn to perform a *series* of selections by associating each with the one following. This would still be a task of the same order, but a more complicated one; and in investigations of this kind earnest students of animal intelligence have obtained important evidence as to the capacities and limitations of animal thinking. Such psychological questions are asked in a different temper from that which prompts the stage performances, and lead to far more useful results.

And so we come last to the other side of our inquiry, why this kind of a performance is so generally accepted at its face value, why educated persons will attribute to the horse (as they do to the Berlin horse), the insight to recognize that 27 divided by 7 gives 3 with a remainder of six, that ¼ must be added to make a unit out of ¾, or that at 12:17 one must wait 43 minutes for one o'clock! Indeed, so wide-spread were the misleading accounts of this learned animal, that a commission of

inquiry was appointed to investigate the whole affair; and upon this commission sat a professor of psychology of the University of Berlin. Though the foregone conclusion was reached that the performance did not exhibit 'a scintilla of anything that may be regarded as thought,' it certainly seems incongruous that so serious an inquiry should have become desirable. Only one point of interest seems to have been elicited, namely, that the horse's master or the bystanders may have frequently been honestly unaware of giving the sign which the keen senses of the horse caught as the indication to stop pawing. Perhaps we need not too pointedly raise the question as to how far these exhibitions intentionally deceive their audiences. Wherever systematic training enters, it follows that the trainer must realize how wide is the gap between what is done and what is pretended. Self-deception on the part of the showman can not be held accountable for more than a slight portion of this discrepancy. Yet still truer is it that if people were not ready to credit such remarkable powers to the horse or the dog, such exhibitions would find no favor. It is partly because animals can really do many things that are wonderful in themselves and, if performed by men, would require considerable rational powers, that we are inclined to credit them with capacities for learning similar to our own. This tendency can be held in check only by an appreciation of the complexity of even a simple piece of true reasoning, of how essential it is to appraise an action in terms of the process that led to it, and how indirect is the revelation of process that comes from the knowledge of the result alone. When this simple lesson in psychology is clearly recognized as furnishing a sound basis for judgment, there will be less tendency to believe that horses can take unto themselves brains with a capacity to multiply and read, as to believe that a horse has suddenly sprouted wings, even though such a Pegasus is pictured on the posters displayed in front of the exhibition hall.

People would also less easily succumb to such deception if they stopped to consider that in regard to these animal performances they must earn the right to an opinion by some simple measure of initiation into the arrangements of what impresses the uninitiated as a remarkable exhibition. The first attitude is naturally that of wonder, and in lack of any detailed knowledge of what the trick may be, the tendency is strong to credit, at least in part, the explanations that are advanced. Once this attitude is overcome and the kind of training that prepares for the performance is understood, the whole affair loses its marvelous aspect and becomes a mildly interesting demonstration of animal training. A brief glimpse of the mechanism behind the scenes is quite sufficient to balance the glare of the footlights and leave the spectator in possession of his usual measure of human intelligence that enables him to appraise sympathetically but sanely the intelligent powers of animals.

THE WORLD STATE

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IN the last decade certain disconnected movements have accomplished something in the way of bringing about a world state, and other movements are on foot to bring about a completion of this general movement. The Hague Peace Conference (1899) brought about the establishment of a permanent international court of arbitration or the international department of justice; the Interparliamentary Union is trying to effect the establishment of a world parliament or congress, or legislative department, and if possible a world executive department. The purpose of this article will be to deal with the history and nature of each of these movements, to point out the reasons why the present movement ought theoretically to succeed and to discuss the obstacles to a successful realization of such plans.

1. *The Hague Peace Conference and the Hague Tribunal.*—In the summer of 1898 the Tsar invited all the principal states of the civilized world to send delegates to discuss concerted action for the maintenance of a general peace and the amelioration of the hardships of war and to plan for the possible reduction of the military and naval armaments of the world. This conference met May 18 to July 29, 1899. It was composed of one hundred delegates representing states having standing armies and navies; twenty-six nations in all were represented. The Papacy, the Transvaal Republic, and the states of Central and South America were not represented. The results of the conference were twofold: (1) Certain arrangements concerning warfare were made and (2) a permanent court of arbitration was established.

The arrangements concerning warfare need not occupy our attention; suffice it to say that a number of resolutions were adopted which tend to make war less brutal and have in view the ultimate reduction of military and naval armaments. Besides these humanitarian efforts of the conference, it accomplished what will be historically much more important, namely, the establishment of a permanent international court of arbitration. The powers agreed to submit all serious cases of international dispute for decision to an international tribunal. The conference provides for the selection of persons who shall constitute a permanent tribunal for six years. Each power can choose not more

than four members, who must be learned in international law. If a dispute occurs the disputants select two of these four from each country, or others not permanent members. These parties choose an umpire, and the settlement is to progress according to stipulated arrangements of procedure. So by this conference a *world tribunal* was established.

Strange to say, the nations did not submit any cases for arbitration in this court until the year 1902. To the present time five cases have been submitted. The first was the Pious Fund Case, 1902. This concerned a dispute over the disposition of a fund created for the support of certain missions in Mexico. In 1697 the Jesuits in Mexico had collected a fund for their monastic and missionary enterprises. After the abolition of the order of Jesuits in 1768, the government seized the property of the Pious Fund, but distributed its income among the missions concerned. After California became a part of the United States, these annual payments were not made to the missions in California. Our government protested on the part of the missions concerned, but to no avail. Finally, both departments of state concluded to let the matter be judged by the Hague Tribunal, and there the award was given to the claimants of the United States. Mexico was asked to pay the arrears and to continue the regular annual payments. Another case was between Venezuela, on the one hand, and a number of European countries and the United States, on the other. The chief facts of the case are the following: Owing to numerous revolutions in Venezuela, the government was heavily in debt and was unable to meet its financial obligations to European and American creditors. Venezuela disagreed as to the amount to be paid and wanted time to reorganize her finances. Several of the European countries brought pressure to bear on Venezuela with little success. Finally, it was decided to arbitrate the claims at The Hague. This was accomplished in February, 1904. The claims in the aggregate did not amount to very much, but the precedent was very important. Decisions in the other three cases have not yet been rendered.

Fully as important as the cases which have been submitted to the Hague Tribunal is the recent agreement of Norway and Sweden. In drawing up the final terms which provided for the peaceful separation of Norway and Sweden, those two powers agreed for a period of ten years to submit to the Hague Tribunal all matters of dispute, except those which affect the independence, integrity and vital interests of either. Similar treaties of arbitration have been drawn up by the other powers, but this treaty differs from the others in one important respect. In the other treaties either party decides whether the point in dispute is of vital interest or not. In the case of Norway and Sweden, the Hague Tribunal decides whether the point in dispute is of such vital importance as can not be decided justly by the tribunal.

So we see that the newly created department of justice has had very little to do—but the fact that it has had any disputes at all to decide is a very hopeful sign. The tendency will undoubtedly be to have more cases submitted. The example of Norway and Sweden may be followed by other states. A more valuable precedent would be a similar arrangement by two first-class powers.

2. *The Interparliamentary Union,* or the attempt to establish a world congress or legislature. At present there is in existence an organization called the Interparliamentary Union; it is composed of members of the various legislative bodies of Europe and America; its object is to have conferences periodically to discuss the means of bringing about an international legislative body—a world congress or parliament. This union was founded in 1888 in Paris as a result of the work of William Randall Cremer, M.P., an English carpenter and labor unionist. In 1889 the first regular conference was held in Paris, and since then meetings have been held at most European capitals and in some other important European cities and in St. Louis. It now has more than two thousand members, all of whom fill seats in some national parliament. There are two hundred from the United States. Membership is voluntary and lasts as long as the members retain seats in their respective parliaments or legislatures. In discussing this union we shall note its accomplishments to 1904, the work of the meeting at St. Louis in that year and its most recent efforts to create a world parliament.

The achievements to 1904 are rather difficult to state. The movement has grown gradually; it has had practical statesmen as organizers, leaders and members; their influence has been great in creating and stimulating a sentiment in favor of universal peace and the means of attaining that peace. From the beginning the conferences have attempted to bring about international arbitration, and it is interesting to note that at the Hague meeting in 1894 the conference declared in favor of a permanent court of arbitration, and a commission of six men was appointed to draw up plans for such. Thus it should be remarked that this conference anticipated the Hague Peace Conference by five years, and that the main work of the Hague Peace Conference was due in no small degree to the work of the Interparliamentary Peace Conference.

One of the most prominent leaders, at least the most prominent American leader, at present is Richard Bartholdt, congressman from St. Louis. It was due to his influence at the 1903 meeting at Vienna that the union held its conference at St. Louis in 1904. At St. Louis the famous St. Louis resolution was drawn up by Bartholdt and adopted unanimously by the conference. It declared in favor of the following things: (1) There should be a conference of nations to con-

sider the universal execution of treaties of arbitration; (2) a congress of nations should be created in which every nation shall have representatives. Such sentiments had been expressed before; but this seemed to be greeted with more enthusiasm than any other similar proposal of the past. After having closed the session at St. Louis, the members of the conference visited Washington and requested President Roosevelt to invite the governments of the world to send delegates to a Second International Peace Conference. This he did. All of the powers replied favorably except Russia and Japan; their refusal was owing to the prosecution of the Russo-Japanese War. When hostilities ceased it was thought that Roosevelt would ask the Belgian government to issue a formal invitation to all powers concerned. But during the Portsmouth Peace Conference the Tsar, through his diplomatic representatives, expressed his desire to have the privilege of calling the Second Peace Conference, since he had called the first. Roosevelt gladly consented. Just recently the Tsar summoned the conference to meet in the fall of 1906.

Hitherto the work of the Interparliamentary Union has been merely preliminary, working up an organization, creating a desire for an international congress. In the past year important steps have been taken. In August, 1905, the union held its thirteenth annual meeting at Brussels. Here two things of importance were accomplished. In the first place, the South American and Central American republics were invited to send delegates to the next annual meeting of the union. Up to that time the Latin American states had not been asked to participate in this movement. Secondly, a commission of seven members was appointed to draw up a plan for an international congress. Mr. Bartholdt was the American member of the commission, which met in Paris in November, 1905. The plan of the commission provides: That an international legislature of two houses shall be established; that the lower house, or popular branch, shall represent the various legislatures of the world; that the upper house, or senate, shall be appointed by the various governments; and that this legislature shall meet periodically, probably at the Hague. This plan of the commission will be the basis of discussion at the next meeting of the union.

So far the Interparliamentary Union has merely created an organization which has been given no legal status or official recognition by the various governments. It has had no appreciable influence on international relations. Nevertheless, its work to the present time has been of considerable value and importance. It has secured the membership and earnest support of the highest-minded and most capable legislators of the world. Through its members and its own influence it has created and stimulated feelings in favor of universal peace, and

is ready to contribute what is perhaps a very satisfactory means of maintaining this much-desired universal peace.

3. *The World Executive.*—To the present time no definite plan for a world executive has been proposed; no movement to establish this has been put on foot. Provisions for this department will no doubt be made later as the occasion requires. No one knows what form it will take. It will hardly be delegated to one man, or even a few men. The international parliament may appoint a committee for all necessary administrative work; this may be divided into a number of bureaus having charge of the various kinds of administration. If any armed coercion is necessary to enforce international laws, the combined fleets of a number of powers may be used, as has been the case in the last century when the powers coerced Turkey.

4. *The Purpose of the World State.*—We have been discussing the origin, organization and characteristics of the proposed world state—now a few words as to its purpose and the place it will fill. Its purpose will be: (1) To provide a definite recognized code of international law; (2) to establish a tribunal which will apply this law, which will arbitrate disputes arising between nations and prevent the disagreeable and disastrous clashes between the peoples of the civilized world. International law at the present time is unsatisfactory. It does not have the force of law as does municipal law; it is not uniform. There is need of a legally constituted body to weed out inconsistencies, to bring in uniformity, to make new laws for the numerous points which are still undecided and which are bound to appear as the intercourse of nations becomes more and more extensive. No one will dispute that the world state will fill a definite place.

5. *Why the Present Movement for a World State ought to succeed.*—A proposal to establish a world state will naturally have its critics—many will doubt the success of such an undertaking. But there are a number of reasons why success can be hoped for some time in the future. Immanuel Kant in his 'Perpetual Peace'[1] declares that the following things are necessary for a world state: (1) All nations should have representative government; (2) successful systems of federal government must have been established in part of the world; (3) there must be a moral force to support the effort. This statement is mere opinion, but the opinion of this writer may well be cited as worth consideration. It seems to us that these things are essentials. To what extent are these requirements fulfilled at the present time?

Representative government has been attained by all the christian states of Europe except Russia; and undoubtedly the Russian people will also secure some measure of political liberty before the present disturbances are permanently allayed. All important nations and

[1] 'Saemmtliche Werke,' Vol. VI., pp. 416–427.

communities outside of Europe have their affairs settled by representatives of the people—the United States, Canada, Australia, Japan. Even China has recently appointed a commission to travel in Europe and America to inspect the best forms of representative government. Federal government has been successfully tried in a number of cases—the United States, Germany, Switzerland, Canada and Australia. The moral sentiment which will support such a movement has been increased very noticeably in the nineteenth century. The idea of the brotherhood of man has gained great strength; there is a growing idea that moral law is fully as binding on nations as on individuals; there is an ever increasing number who think it is just as wrong to kill a man in battle as to commit murder. Then along with these forces there is the so-called 'Welt-Geist,' a cosmopolitan spirit, the idea of world-citizenship.

The hope that the powers may some time unite to establish a permanent international legislative body does not seem unreasonable. The past century produced what is called the Concert of European Powers. They have met at irregular intervals to discuss affairs of mutual interest; the enactments of some of these congresses have become recognized international law. A few examples will suffice. The Congress of Vienna (1814–1815) rearranged the map of Europe and undid much of the work of the revolutionary era. The Near Eastern Question has frequently occasioned united action on the part of the great powers of Europe. The navigation of the Rhine, the Elbe and the Danube has been regulated by European congresses, held at various times. In 1856, at Paris, the powers drew up rules concerning privateers, neutral goods, goods contraband of war and blockades; and these rules are a part of recognized international law to-day. In 1888 the Suez Canal was neutralized. In 1884 and 1885 the powers assembled in order to partition Africa peaceably and to make definite regulations concerning African affairs. In 1874, at Berne, was established the Universal Postal Union, whereby most of the nations of the world have secured a more adequate foreign-mail service. In the past few months the conference of Algeciras met to discuss international interests in Morocco. These facts show that in the past and present century the nations, not only of Europe, but of the whole world, have successfully cooperated in affairs of mutual interest. If they can meet irregularly for special purposes, it is not at all fanciful to think that at some future time they may meet periodically to make laws concerning all affairs of international polity.

There are also some practical reasons why the movement can and ought to succeed. The first is economic. The establishment of a world state will tend to secure peaceful intercourse between nations; there will be less and less occasion for war; international relations will

be more definitely defined; more and more disputes will be settled by arbitration in the court of the world. Such a state will receive the undivided support of the commercial interests of the world, for commerce thrives best in times of peace. Since this is an industrial and commercial age, the business interests ought and will support a movement to bring about and preserve peace. The practical or mechanical obstacles to the establishment of a world state are fewer now than ever before; in fact, one might almost say they do not exist any longer. By means of past inventions and discoveries the world is more closely united, more thoroughly bound together, than ever before. Steam railways, steamships, the telegraph, telephone and wireless telegraphy and scores of other inventions have annihilated distance. The formation of a world union is easier than ever before.

6. *Obstacles to the Success of the Movement.*—Unfortunately such a movement as we are considering will have a number of serious obstacles to meet and overcome. Perhaps the most potent hindrance to the speedy establishment of a world state will be the existence of strong national feelings, the antipathy of the nations of Europe and the local patriotism on the American continent. It will be a long time before race hatred and national enmity will be allayed; it will probably be centuries before 'jingoism' and local patriotism will be supplanted by reason and a cosmopolitan spirit. But in connection with this obstacle, one ought to note that a great amount of this cosmopolitan spirit does exist now and will continue to grow. Happily this spirit or feeling is not to be found solely among the upper and educated classes, but among the working classes also, and especially among the working classes of Europe. With them, however, the feeling is not necessarily an end in view, but a concomitant of their great struggle. The workingmen of Europe, organized under the banners of labor organizations and socialism, declare that their fight against capitalism is an international struggle, that the capitalistic régime is omnipresent and everywhere opposed to labor.

Another obstacle to the establishment of a world state is the hostile attitude of the monarchical governments of Europe. Most of them are more or less jealous of their sovereignty and hate to have it curtailed in any way; they scorn being forced to arbitrate their disputes instead of fighting them out. This is not a mere assertion and can best be illustrated by the attitude of Germany. At the Hague Peace Conference in 1899, the German delegates declared that arbitration was incompatible with the divine right of kings to rule. The Emperor William has openly manifested his opposition to a permanent court of arbitration. When it was proposed that the German-Venezuelan question be submitted to the Hague Court, William II. proposed that the matter be left to President Roosevelt as arbitrator. But Roosevelt de-

clined and advised recourse to The Hague. A world state implies republican government; it will necessarily be representative, not of monarchs, but of nations and peoples; this is not in harmony with the divine right of kings. But this opposition of the monarchs will not be insurmountable. If a strong sentiment in favor of arbitration or federation be manifested, the monarchs will very discreetly give way, as has been their wont in the past century.

7. *Conclusion.*—This article has been merely an attempt to give an account of a tendency, its history and characteristics. The information available is exceedingly scarce; what is available is rather scattered and isolated; the status and force of the movement at any given time are difficult to estimate; the very nature of the movement itself is vague and visionary, it seems too fantastic to be practical, the attempt seems premature; it is the work of idealists, of optimists; their efforts are naturally looked upon with suspicion and discredit by conservatives and realists. Nevertheless, idealists prepare the way for movements which quicken the pulse of humanity and which bring about reforms both small and great. No person living to-day may ever see the establishment of a world state with power to execute its laws. However, we have seen that part of the machinery of a world state has been constructed and that other parts are in the process of construction. It may take decades before this world state will exercise any influence. But it seems no small accomplishment for an age to create the machinery of a world state which mankind will use to good advantage when there exists a sufficiently strong feeling of the need for and desirability of such an organization.

Too much must not be expected of this movement. The world state will not bring about immediate disarmament, but if it succeeds it will bring about compulsory arbitration; it will establish a state of law among the nations. The more disputes settled by arbitration, by judicial decision in accordance with laws passed by a world congress, the fewer will be the occasions for war. If the need for war is decreased, armaments will be less necessary and possibly may be abandoned. Inasmuch as an object so worthy may ultimately be attained by this now rather visionary movement, it at least merits our attention and sincere hopes for its ultimate success.

THE MEASURE OF 'PROGRESS'

By Dr. EDWARD S. HOLDEN,
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NO words are more common in the mouths of orators than the phrases: The march of Progress—the growth of Civilization. When we say that the twentieth century is in advance of the sixteenth, do we mean that it is so in each and every respect? Do we mean that men in general have now a keener feeling for art than in the age of Michel Angelo; a finer knowledge of justice than in the century of Socrates; deeper religious feelings than in the days of Wesley, or of St. Thomas Aquinas?

It is not easy to answer such questions offhand in any large way. The modern feeling for art is perhaps more wide-spread, but certainly far less keen, than in the Italy of the sixteenth century. If we say that our sense of justice is finer than that of the Greeks who condemned Socrates to death, and of all the centuries before our own, how is it that successive generations of men have preserved the narrative of his last day with sacred care? What are we to say of the religious feelings of the day of Wesley compared with the ethical efforts of the day of Felix Adler? It is clearly not easy to give answers of real import to questions of the sort. We need a better insight into the meaning to be attached to words like progress, civilization and the like. Definitions taken out of dictionaries will not answer.

It has been my fortune, lately, to make a fairly thorough study of that wonderful renaissance of science which began in the days of Roger Bacon, in the thirteenth century, and to endeavor to connect it with its origins in Alexandria, its precursor in Mohammedan Spain and its successor in the century of Galileo. There is no space here to present even a summary of such a study,[1] but it may not be out of place to give a few paragraphs which bear on the general and important question: how are we to measure progress?

In comparing the view-points of different ages with our own we continually meet with surprises. The uncritical attitude of the men of the thirteenth century towards miracles and wonders is little less than astounding to us. Our thought seems to be ages in advance of theirs. On the other hand, we often meet with an insight that has what we call the distinctly modern note. An instance from literature will illustrate:

[1] See Popular Science Monthly, Vol. LXIV., pp. 316–342, and elsewhere.

A man's character is his fate

is a sentence that one would assign to Taine or to Stendahl in the nineteenth century if one did not know it to have been written by Heraclitus in the fifth century before Christ. In like manner, some of the scientific processes of Hipparchus, Archimedes and Roger Bacon are so 'modern' as to bring a glow of delighted wonder when they are met with. Their failure to draw certain conclusions that seem almost obvious to us is equally astonishing. A formal explanation of the differences and of the resemblances of ancient ages with our own might be somewhat as follows. We may suppose that a completely developed man of our day has educated his sympathies and intelligence to have outlets in a certain large number of directions—let us say, in the directions A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. It is possible, however, that some few of these outlets are absent, or nearly closed, E and O, for instance. The men of the eighteenth century may be supposed to have had fewer outlets, and those of the thirteenth still fewer; but the intensity and refinement of their sympathies in certain directions may not have been less, but far greater, than ours. The feeling of the thirteenth century for religion, and of the sixteenth for art, for example, were not only different in intensity, but very different in quality, from our own.

When we make a formal comparison of our age with that of St. Thomas Aquinas and of Newton, the table might stand thus:

A, B, C, D, –, F, G, H, I, J, K, L, M, N, –, P, Q, R, S, T, U, V, W, X, Y, Z, XX century.
a, b, c, d, e, f, g, h, i, –, –, –, m, n, ... XIII century.
a, b, –, –, –, –, g, h, i, j, k, l, m, n, o, p, q, r, ... XVIII century.

If in a comparison of the thirteenth century with the twentieth our discourse is upon the matters A, B, C and D we may find their insights, a, b, c, d, singularly like our own. The case may be the same for the matters G, H, I compared with g, h, i. But if, by chance, we are comparing their insight e with our absence of insight, or our X, Y, Z, with the blanks in their experience, we are astonished at the difference of outlook.

This formal and unimaginative illustration may not be quite useless in clarifying one's thought upon a matter easy to express in words and exceedingly difficult to realize. It is essential to admit the presence of blanks in the experience of past centuries; and also the presence of insights upon fundamental matters which are astonishingly different in intensity and in quality from our own. The experience of the thirteenth century was handed onwards to succeeding ages; it could be understood by the ages near to it; words continued to mean in the fourteenth very nearly what they meant in the preceding century. But as ideas changed, the signs for ideas changed with them; and we must be constantly on our guard lest we unthinkingly admit an old form as if it

had the new meaning. Consider, for example, what astrology meant to Roger Bacon and what it means to us. He had no difficulty in reconciling the fateful influence of the stars with a scheme of salvation for men possessed of free-will. Words had different meanings to him and to us. His mind was conscious of no conflict between his religion and his science. His religion—that of the thirteenth century—is in absolute conflict with our science—that of the twentieth. This one example may stand as a type of many that might be brought forward.

The Greek architects long ago discovered that a cylindrical column looked at from a distance would not appear to have its two sides parallel, but that on the contrary these two sides would be hollowed in, convex towards each other. A long colonnade of cylindrical columns would exaggerate the unbeautiful effect. The Greeks *felt* the lack of beauty and afterwards proceeded to discover a rule for making the outer surface of a column convex, so that a colonnade of convex columns would appear to the spectator to be comprised of cylindrical, or conical, surfaces, beautiful to the eye. This increase of the middle diameter of columns was called *entasis*.

In the early part of the nineteenth century, an English architect, Mr. Penrose, visited the Parthenon, for the purpose of making accurate measurements of its principal dimensions. What was his astonishment to find that something of the nature of *entasis* had been given by the Greeks to the architraves, cornices and other members of the building. The long horizontal lines of the friezes were convexed outwards in order that they should not appear hollow to the eye. Other horizontal members were also convexed in order that they should not appear to tilt upwards. Similar measurements made on the Maison Carrée, at Nîmes, demonstrated that like rules were employed by the subtle architect for similar purposes. Measurements made on the temples of Egypt have shown that their floors are convexed in order that they may appear flat.

The Egyptians, the Greeks and even the Romans were possessed of eyes and senses so subtle that certain architectural devices were demanded by them in all edifices designed to give high pleasure. The entire western world was ignorant of these devices until a couple of generations ago. With the destruction of Rome, even the traditions of these changes were lost, so that all the Gothic cathedrals of Europe and every great building erected between the end of the fifth century and the middle of the nineteenth were constructed on geometrical lines, so to say, and not to satisfy the eye.

Mr. Penrose's discoveries were made with a foot-rule, *not* by a sensitive eye. They have borne fruit in our own time and in our own great city. The beautiful library of Columbia University is built on Greek principles. Let any one glance along the edge of one of the steps of

the main approach and determine for himself how far it departs from a horizontal line. Our eyes will soon come to demand such curved lines. Straight lines will soon seem hollow to us as they did to the Greeks. But, note the difference. We have come to our comprehension of such forms by literary, by archeological, by mensurational, steps, while it was a matter of feeling to the Greeks, or to their predecessors. Certain insights and sympathies of theirs have been atrophied in our ancestors. Can we say, then, that the appreciation of beauty is as keen with us as it once was to other peoples less 'progressive,' less 'advanced'?

Instantaneous photography has familiarized us with the various motions of the horse. The horses on the frieze of the Parthenon and in the paintings of the Renaissance are depicted in attitudes which are impossible. Because the horses of Mr. Frederick Remington's pictures are recognized by us to be true to life, does this show a greater sense of the beautiful? We have gained our new knowledge by photographic and scientific methods, but can we say that our æsthetic sense in this regard has become more refined? Is our analysis more subtle than the Greek synthesis?

We are all so used to the admission of the high sense of beauty of the Greeks that we consciously form our standards by what we suppose to have been theirs. We praise the classic purity of the Parthenon, not only the purity of its lines, but of its unbroken color—the native color of its marble. But in doing this we forget that the Greeks covered almost the entire surface of this pure marble with thick coats of color—parts with vivid blues and reds. A model of the Parthenon painted in its ancient colors seems crude to modern eyes. But are we to conclude that our sense of beauty of color is more keen and refined than that of the Greeks, our acknowledged masters? Is it true that the rains of centuries were needed to wash off colors carefully laid on by the builders so that it is only now, and to us, that the Parthenon finally emerges the one perfect building of the world?

As with Greek buildings so with Greek statuary. We are used to praise the classic purity of their white marble gods and goddesses, forgetting that the most famous statues were made of gold and ivory, enameled with images of animals and flowers, with metal bracelets and ornaments fixed to marble, or again painted in parts like the Hermes of Praxiteles or the Athene at Elis. The ears of the grave, serene and august Venus of Melos are pierced for metal ear-rings. To us she seems all-sufficing and stands alone. It is more than likely that the original statue formed a part of a group—Venus placating the wrath of Mars. Do we, in fact, at all comprehend what the Greeks meant to depict by their images of divinities? Would a Greek, returning to earth, in the least understand the interpretations of the æstheticians? Have we then progressed beyond the comprehension of the men who made these marvels? Is it permissible to take refuge in that

fatuous phrase—they builded better than they knew—when, in fact, 'they' knew exactly what they were about, and possessed a consummate technique to express precisely what they chose?

There is nothing more certain than that the Gothic cathedrals of Europe were built by architects who knew their business and whose plans were definite and precise. The architects' drawings for some of these cathedrals are extant and even the builders' model for one of them. It was intended that the towers of Notre Dame, for example, should be crowned with spires like those of the cathedral of Lichfield, for instance. But circumstances of various sorts worked to prevent the completion of the spires on most of the great cathedrals, and they were left as towers, as at Notre Dame and on the front of York. Our own standard of beauty has been fixed by what we actually have seen, and if Notre Dame were now to receive lofty spires as a crown to its towers, most of us would find its beauty marred. Are we then to conclude that we, and not the architects of old time, are the possessors of the truest standards? Shall we say that we comprehend the beauty of a Gothic cathedral better than the builder who designed it?

It would be easy to extend comparisons from the material objects of art to the immaterial institutions of society, to contrast our notions of justice and of government with those of the ancients, for example. We are just as sure that all our social institutions are better than those of old time as we are that the towers of Notre Dame are more beautiful in their present unfinished state. But should we not pause before unthinkingly accepting either conclusion?

There is no member of a ladies' culture club in the northwest who is not ready to declare that the very essence of classic purity is to be found in the unpainted Parthenon or in an uncolored Venus, and equally sure that the constitution of the state of South Dakota contains the quintessence of political wisdom. History throws a doubt on the first conclusion and suggests that it may not be amiss to reexamine the last from time to time. 'Progress' is something more than the difference between the state of affairs on a Tuesday, compared with that of any preceding Monday. The measure of progress is not the discrepancy between the inventories—moral or material—of one epoch and of a later one. There is no space here to attempt to say what a true measure of progress might be, but it should not have been quite useless to suggest that the measure in question is not so simple as we commonly assume; that the differences between races and epochs show retrogressions in many fields as well as progressions in many others. The lesson is simple—so simple that it may even be resented. Yet it is so difficult that there is no day that passes without a proof that it is not yet learned.

EFFECTS OF IMMIGRATION ON HOMICIDE IN AMERICAN CITIES

By MAYNARD SHIPLEY

IN his recent report for the Bureau of Immigration, Commissioner-General Sargent again calls attention to the dangers arising from the inadequate immigration laws of the United States. He contends that the time has come when some more effective restrictions must be introduced than those that have so far obtained. Although protests against prevailing legislation on immigration have been heard for more than fifty years, real cause for alarm has, perhaps, existed only within recent years. The total number of immigrant arrivals had never exceeded one half of a million during any one year previous to 1881. Since 1820, we have received 22,932,905 immigrants, an annual average of 269,798. During the fiscal year ending June 30, 1905, the total number of aliens who entered this country (exclusive of Canadian and Mexican immigrants), was 1,026,499, the largest aggregate of immigrant arrivals in any one year of our history. At this rate, we should receive during the next twenty years the same number of aliens that flocked to our shores during the past eighty-five years. As most of the newcomers of recent years have belonged to a class having neither trade nor profession, and as many of them are totally illiterate, it would seem that some very grave consequences must ensue as the result of their congestion within an area of a comparatively few square miles of the Atlantic seaboard. The attempt is now being made to transport many of them to those sections of the United States which can more readily absorb them. In just how far the success of this movement would mitigate present evils the future alone can reveal. Meanwhile, the problems arising from the presence of these alien hordes 'loom so largely in the prospect of our country,' declares Mr. Sargent, 'that it may be said without giving just cause for the charge of exaggeration, that all other questions of public economy relating to things rather than to human beings shrink into comparative insignificance.'

The great danger from this increase of immigration, however, arises rather through the change in its character than from mere increase in numbers. Once recruited mostly from the United Kingdom, Scandinavia and Germany, the greater part of our immigrant population now comes from Russia, Poland, Austria-Hungary, Bohemia, Italy and the Balkans. During the decade 1881–90, the proportion of immigration

from the foregoing countries was about 20 per cent. of the total; during the ten years following, about 50 per cent. In 1902 these countries furnished about 71 per cent. of the total immigration, a proportion exceeded during the year just ended.

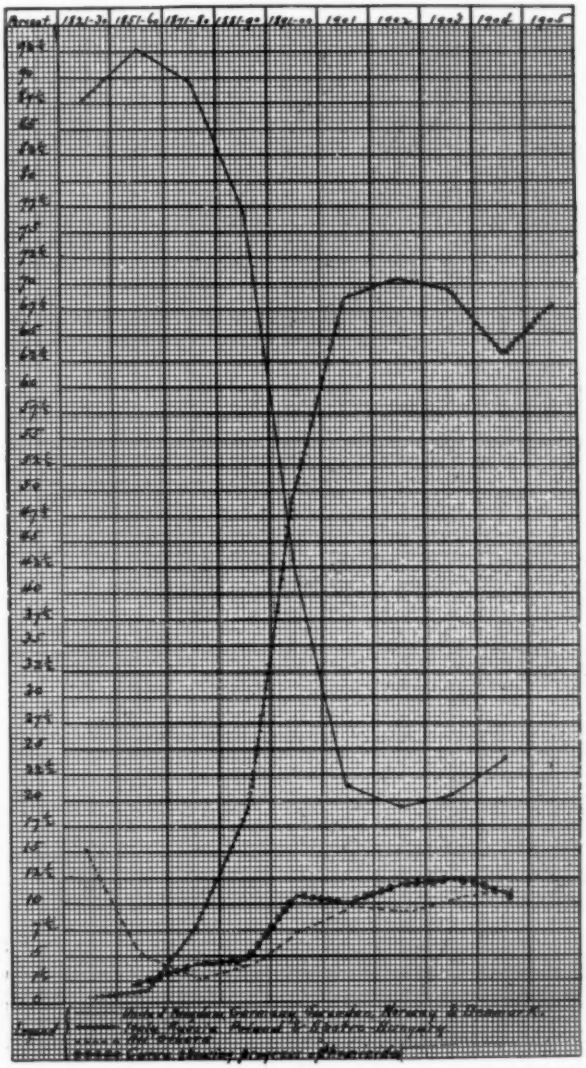

FIG. 1. DIAGRAM SHOWING CHANGING CHARACTER OF IMMIGRANT POPULATION INTO THE UNITED STATES

The accompanying figure (No. 1) shows graphically the precipitous decline of immigration from northern Europe, the vast influx from southern Europe, the proportionate increase from all other countries,

and the deplorable rise in the ratio (per 100,000 of population) of deaths from homicide.[1]

The figure below (No. 2) shows graphically the source and extent of the annual immigration into the United States since 1880, the annual number of arrivals from Italy being given separately because of its special importance in the present inquiry:

The records of our penal institutions prove that it is not the alien as such who adds unduly to the number of homicides in this country; they show rather that the alarming increase in crimes of violence is due to certain particular elements of our immigrant population.

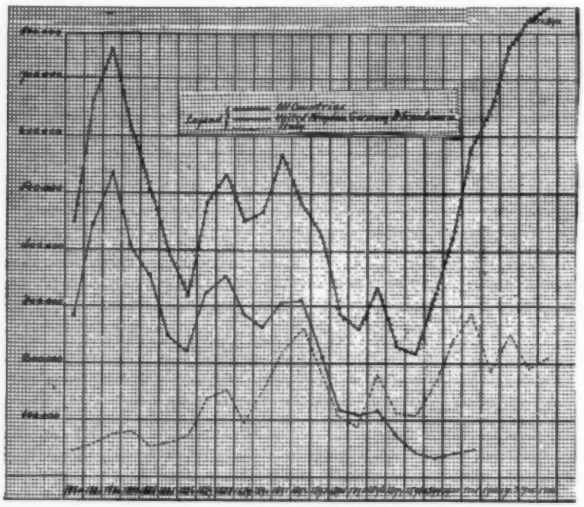

FIG 2. GRAPHIC CURVES SHOWING CHANGING CHARACTER OF IMMIGRATION INTO THE UNITED STATES.

Among the nationalities represented in our prisons, the sad pre-eminence for murder belongs to the alien Mexican, 121 of whom are now confined for deliberately killing a fellow man, though their total number in this country hardly exceeds one hundred thousand. Among an equal number of alien Irishmen less than three have been convicted on the charge of murder, and of German and English immigrants not more than four in each one hundred thousand are held for this grave offense. Among Scandinavian aliens the ratio is still smaller. Next to the Mexicans, the Chinese are the most murderously inclined of any foreigners present, 65 in each one hundred thousand of their

[1] The curves of immigration show the per cent. each group of race elements bears to the total influx of aliens; the curve for homicides shows the actual number of persons who met death by homicide in each 100,000 of the total population of the United States. The latter figures are based upon the mortality statistics of the United States Census Reports.

number being now held for murder. That there is danger in the vast increase of immigration from southern Italy is evidenced by the fact that of each one hundred thousand of alien Italians in this country 50.2 are held for murder. There is no question here of race prejudice, as may be seen by the following diagram (Fig. 3).

Unfortunately, the tendency of immigrants is to concentrate in large cities. The proportion of foreigners is about four times greater in the 161 cities of over 25,000 inhabitants than in the remainder of the country; hence the relation of increasing immigration to the increase of crimes of violence can be best studied through the police records of large cities. Naturally, such a task is fraught with many difficulties, owing to the want of adequate data. By confining the scope of the present inquiry to the effect of immigration on crimes involving the loss of human life, and by comparing prison statistics with the reports of chiefs of police, sheriffs and health officers, many obstacles, insuperable in any study of wider scope, are avoided.

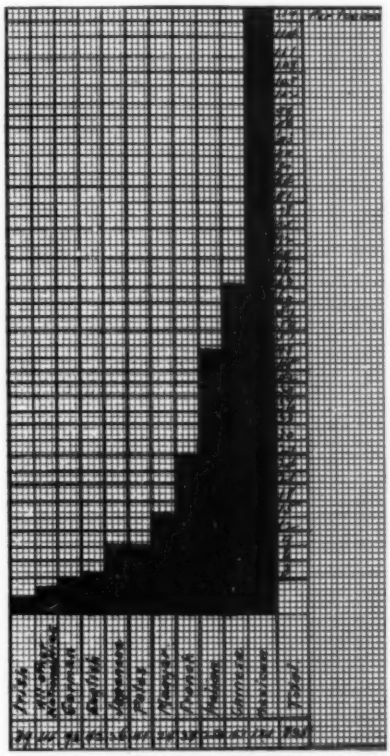

FIG. 3. TABLE SHOWING NUMBER OF FOREIGNERS HELD FOR MURDER IN AMERICAN PENAL INSTITUTIONS, WITH THEIR RATIO PER 100,000 OF POPULATION.

As the records of our penal institutions show which elements of our foreign population are most given to homicide, those cities should have the higher ratios of arrests for homicide which contain the greater proportions of aliens from the countries shown in the figure to produce the greater proportions of murderers. But there are many disturbing factors to be reckoned with, chief of which is the presence in many of our cities of large numbers of a socially inferior race of native-born citizens, the negroes. The United States Census Report on Crime, for 1880, shows that the tendency among negroes towards crimes against the person was 100 per cent. greater than among the native whites. The report for 1890 shows that the negroes had been convicted of three times more homicides in proportion to their number than had the foreign whites; whilst as compared with the native white population they appear to have been about six times more murderous. Nearly two thirds of the prisoners charged with murder were in the south.

Capable as many of the better-conditioned blacks are of attaining all the virtues of the average white citizen, and, in some instances, of transcending them, the American of African descent is, on the whole, fully as prone to homicide as are the native Indians, whose savage cruelty he does not hesitate, when excited by the lust for blood, to emulate. In Lexington, Kentucky, for instance, where 38 per cent. of the population are negroes, 13 per cent. of whom are illiterate, the annual average of arrests for murder and manslaughter during the four years 1901–04 was 40.07 per one hundred thousand of inhabitants, the highest ratio of any city of which statistics covering more than one year are available. Only 3.5 per cent. of the population are of foreign birth, hence the great number of homicides implied by these figures can not be attributed to the immigrant population.

On the other hand, in cities where the proportion of negroes is small, the higher ratios of arrests for homicide correspond with the higher percentages of immigrants from certain countries. Other things being equal, the lower ratios prevail where the foreign element is from northern Europe, and the higher ratios are seen where the foreign element is from the countries shown above to produce the emigrants who are most given to crimes of violence.

The following table shows the ratios of arrests for homicide per one hundred thousand of population in various cities, for the years 1880, 1890, 1900, and the annual average ratios for the last two or more years.[2]

Referring to the last two columns of the table above, it is seen that despite the fact that San Francisco has but a very small negro population (only 0.5 per cent. of the total inhabitants, in 1900), the annual average ratio of arrests for homicide is greater than in Louisville, Kentucky; or in Charleston, South Carolina, where the negro population is relatively large. This corresponds with the fact that San Francisco has a large number of Chinese (about 16,000) in her population; a large proportion of Italians (7,508, in 1900); about 1,500 Mexicans, and a large proportion of foreign born from various countries other than Scandinavian, Teutonic and Anglo-Saxon.

The latest report of the Sheriff of San Francisco County shows that of the prisoners committed to the county jails during the fiscal year ended June 30, 1904, 70 per cent. were of foreign birth, while the proportion of foreign born in the total population is about 34 per cent.

[2] The proportion of *homicides committed* would, of course, serve more accurately as an index of relative criminality, in respect to the crimes of manslaughter and murder, than would the number of arrests therefor. The former statistics not being available in many instances, the latter have been used as a basis for the present study. The writer's thanks are due the many chiefs of police, and others, who have so kindly assisted him in procuring the statistics of arrests for homicide in the various cities mentioned in this study.

TABLE I.

City.	Year 1880.	Year 1890.	Year 1900.	Annual average per 100,000 for the Period.	
San Jose, Cal.	15.91	55.37			
Springfield, Ill.		48.07			
Youngstown, O.	30.10				
Lexington, Ky.	12.00	23.18		40.07	1901–04
San Francisco	13.25	19.39	25.09	19.69	1899–03
Kansas, Kan.		18.27		17.64	1904–05
Louisville, Ky.	16.16		17.09	17.41	1900–05
Charleston, S. C.	1[illegible].00	9.0		16.12	1901–04
Trenton, N. J.		10.44			
New York	3.06	6.73	13.1[illegible]	13.23	1898–03
New Orleans	9[illegible].5	1[illegible].3[illegible]			
St. Louis		7.0[illegible]		11.30	1904–05
Omaha, Neb.		12.10		9.7[illegible]	1901–04
Cleveland, O.		13.01		9.56	1903–04
Atlanta, Ga.		9.15			
Chicago, Ill.	2.79	4.45		9.30	1904
Memphis, Tenn.		9.30			
Newark, N. J.	1.46	1.10	6.90	9.16	1899–04
Denver, Col.				8.21	1903–05
Baltimore, Md.		6.90	8.21	7.74	1898–03
Des Moines, Ia.	13.38	9.98		7.67	1901–04
Bridgeport, Conn.	3.61	8.18			
Jersey City	8.28	7.36			
Richmond, Va.		7.37			
Cincinnati, O.	6.66	4.01	4.29	6.00	1898–04
Hoboken, N. J.	6.45	6.94			
Washington		7.37	6.09	5.56	1902–04
Los Angeles, Cal.		13.88		4.86	1901–04
Springfield, Mass.		4.[illegible]2			
Philadelphia		0.76	2.74	4.93	1899–04
Indianapolis		4.74			
Patterson, N. J.	3.91	1.27		4.51	1901–04
Savannah, Ga.		4.6[illegible]			
Hartford, Conn.		13.15		2.17	1901–04
Buffalo, N. Y.	2.60	3.52		2.93	1902–04
New Haven	1.59	[illegible].45		4.16	1901–04
Scranton, Pa.	2.18	2.65			
Albany, N. Y.		.10			
Boston	1.93	1.33		1.98	1904–05
Milwaukee, Wis.	0.86	0.97	1.0[illegible]	1.77	1898–04
Providence	0.95	2.[illegible]7		1.70	1901–04
Rochester	2.2[illegible]	0.74	0.00	1.53	1900–03
Minneapolis	2.13			0.49	1904
St. Paul		1.[illegible]0			

RATIO OF ARRESTS FOR HOMICIDE PER 100,000 OF POPULATION IN VARIOUS CITIES OF THE UNITED STATES.[1]

The table following, compiled from the mortuary statistics of San Francisco, shows how large a proportion of the homicides committed occur among foreigners:

[1] The annual average ratios of arrests for homicide during the last period given are based upon the population statistics of 1900. Due allowance must therefore be made for increase of inhabitants in some cases.

TABLE II.

Year.	Total Homicides.	Number of Certain Classes killed.			
		Foreigners.	Caucasians.	Mongolians.	Unknown.
1889	23	15	15	8	
1890	28	15	24	4	
1891	24	16	18	6	
1892	23	19	14	9	
1893	22	12	15	7	
1902	43	17	31	12	
1903	46	19	24	11	1

NUMBER OF HOMICIDES REPORTED BY THE HEALTH OFFICER OF SAN FRANCISCO, DURING THE YEARS GIVEN.

The figures above show that of the 199 persons who met death by homicide in San Francisco during the five years 1889–93 and the two years 1902–03, 111, or 55.6 per cent., were of foreign birth, while the total foreign born of the city form but 34.1 per cent. of the population. The undue proportion of murders among the Chinese is easily appreciated when it is stated that the Mongolians comprised 28.6 per cent. of the number who met death by homicide, while they form less than 6 per cent. of the population. The mortality statistics of San Francisco show that during the twenty-five years 1872–97, there were 469 Chinese murdered, an annual average of 18.76. From these figures it may readily be seen that the very high ratios of arrests for homicide in San Francisco are largely attributable to her alien Chinese population. Consulting the District Attorney's Report for 1897 (a report which happens to be available), I find that 41 per cent. of the charges filed for murder and manslaughter during that year were against Chinese.

The table following shows that the annual proportion of arrests for homicide and attempts at murder has varied but little during the years given (omitted years imply missing or unavailable reports).

That the ratio of arrests for homicide has not grown larger in San Francisco concurrently with the general increase of immigration from southern Europe, coincides with the fact that the proportion of Chinese in that city is growing smaller, and that the great influx of European aliens has not yet affected the Pacific coast to any considerable extent. Of the 1,025,000 immigrants who landed on our shores during the fiscal year ending June 30, 1905, at least 76 per cent. went into New York, Massachusetts, Pennsylvania, New Jersey, Ohio and Illinois. Only 431,571 were destined for the west, and but 46,343 for the south.

This tendency of the alien to congest in the great manufacturing cities of a few eastern states is gradually reversing the order of conditions heretofore existing. Twenty years ago the population of Pacific coast cities was much more largely foreign born than at the present time, while in the east the percentage of foreign born in urban communities is increasing. Ten and twenty years ago, as may be seen

TABLE III.

Year.	Population of City.	Murder.				Attempts at Murder.				Manslaughter.			
		No. of Arrests.	No. Released.	No. Held.	Arrests per 10,000 Population.	No. of Arrests.	No. Released.	No. Held.	Arrests per 10,000 Population.	No. of Arrests.	No. Released.	No. Held.	Arrests per 10,000 Population.
1850	34,776												
1860	56,802												
1870	149,473												
1874	183,267	21	9	12	1.1513	70	22	48	3.8195	6	4	2	0.3273
1880	233,959	29			1.2395	134			5.7275	2			0.0855
1881	240,462	22			0.9149	116			4.8240	12			0.4991
1883	253,470	23			0.9074	87			3.4323	22			0.8679
1885	266,478	35	10	25	1.3134	106	53	53	3.9777	24	23	1	0.9006
1886	272,981	20	3	17	0.7326	112	60	52	4.1028	13	10	3	0.4762
1887	279,485	36	9	27	1.2881	137	78	59	4.9018	24	22	2	0.8587
1888	285,989	30	6	24	1.0489	102	59	43	3.5665	17	13	4	0.5944
1889	292,493	33	16	17	1.1282	132	57	75	4.5129	25	22	3	0.8547
1890	298,997	44	9	35	1.4712	98	48	50	3.2776	15	13	2	0.5017
1891	303,375	26	5	21	0.8570	101	51	50	3.3292	16	16		0.5274
1892	307,754	19	3	16	0.6173	100	39	61	3.2493	10	9	1	0.2924
1893	312,132	30	11	19	0.9611	92	54	38	2.9474	11	6	5	0.1922
1894	316,511	34	13	21	1.0742	107	57	50	3.3806	19	15	4	0.4739
1895	320,889	22			0.6855	122			3.8019	21			0.6544
1896	325,268	32			0.9838	131			4.0274	17			0.5226
1897	329,646	26			0.7887	97			2.9425	17			0.5157
1900	342,782	41			1.1961	104			3.0339	45			1.3128
1901	347,161	19			0.5473	110			3.1685	36			1.0369
1902	360,000	29			0.8056					44			
1903		21								49			
1904	450,000	48			1.0666					52			1.1556
1905	467,500												

SAN FRANCISCO POLICE-COURT RECORD—1874–1904.

by Fig. 4, murders were far less frequent in proportion to population in eastern cities than they are now. In the west the reverse is true, because the immigration from southern Europe has had little influence on the growth of Pacific coast cities. In Los Angeles, where the proportion of native born of native whites is exceeded by only four cities (of 100,000 or over) in the United States, the ratio of arrests for homicide has greatly diminished, falling from 13.88 per 100,000 of inhabitants in 1890, to an annual average of 4.86 during the four years 1901–04.

Passing now to the Atlantic seaboard, we find in the city of Newark, New Jersey, a conspicuous example of the effect of immigration on homicide in a city which owes much of its recent growth to alien settlers. In 1900, 29 per cent. of Newark's population was foreign born, the foreign-born Italians alone numbering 8,537, since which year this element of her population has greatly increased.

In 1880, when the Italian population of Newark was very small, the ratio of arrests for homicide was but 1.46 per 100,000 of inhabitants; in 1890 the ratio was even lower, being 1.10 per 100,000 of

population. During the decade following, the immigration from Italy, Poland, Russia, Austria-Hungary and the Balkans greatly increased, and Newark got her full share of all these elements. The police reports of the period following show an increase in the ratio of crimes of violence in general, while the ratio of arrests for homicide in 1900 was five times greater than in 1890. That this great increase was not merely the result of an unusual year is shown by more recent statistics. The annual average ratio of arrests for homicide in Newark for the six years 1899–1904 was 9.16 per one hundred thousand of population; this is on the basis of the population of the census of 1900, more recent statistics not being available.

In New Haven, Connecticut, where the Italian population has greatly increased since 1890, the ratio of arrests for homicide has about doubled during the past six or eight years. In 1880, the ratio of arrests for murder and manslaughter in that city was 1.59 per 100,000 of inhabitants; in 1890, 2.46; and during the four years 1901–04 there were 4.16 arrests per 100,000 of population on the charge of killing a fellow man. This ratio is still quite low, compared with some cities of the east, but the increase is very significant, especially in view of the fact that the second generation of foreigners is always more criminally inclined than the first.

The relation of immigration to the proportion of crimes of violence in urban counties is well exemplified in the various large cities of the Empire State.

In the city of New York, with its million and a half of foreigners, constituting as they now do more than 37 per cent. of the total population, and nearly half of whom are from countries other than those of northern Europe, we find very favorable conditions for a comparatively high ratio of crimes of violence. Consulting the police statistics of New York City, I find that the ratio of arrests for homicide has increased more than fourfold since 1880, rising from 3.6 per 100,000 in that year, to 6.7 in 1890, and 13.12 in 1900. The annual average ratio for the six years 1898–1903 was 13.23 per 100,000 of inhabitants. There are no statistics available showing the proportion of these homicides which were committed by New York's immigrant population. Many of the journals of the great metropolis charge the Italians (of whom there are now about 400,000 in that city) with a large share of the murders committed; and when it is considered that, as shown in a preceding table (No. II.), one out of every 1,906 Italians in this country is held for murder, it is apparent that the charge is not without foundation. Some idea of the problems arising from such a vast influx of aliens as the past few years have witnessed is derived from the records of New York's Children's Court. Of the 7,647 children arraigned during the year ending December 31, 1904, more than half were born in Italy or Russia or of parents born in those countries.

"Practically all of the material brought into the Children's Court," says Mr. Coulter, "is a gift from Europe."[4]

Passing now to the cities which have received few immigrants from southern Europe, we find that the ratios of homicides have changed very little, and that they are uniformly low.

In the city of Buffalo, where at least 73 per cent. of the foreign born population are from northern Europe, the ratio of crimes of violence has remained almost stationary for thirty years. In 1880 the ratio of arrests for homicide was 2.60 per one hundred thousand of inhabitants; in 1890, the proportion was 3.52; while the annual average for the three years 1902–04 was 2.93.

In Rochester, where 85 per cent. of the foreign-born inhabitants are from the United Kingdom, Canada, Germany and Scandinavia, homicides have decreased relative to the population, the ratio of arrests for murder and manslaughter being, in 1880, 2.23 per one hundred thousand of population; in 1890, 0.74; while the annual ratio for the four years 1900–03 was 1.22.

In Syracuse, where 77 per cent. of the population are native whites, and where about 82 per cent. of the foreign-born are from the countries of northern Europe, but six cases of homicide have come under jurisdiction of the police department during the past fourteen years.

Passing south now to the Quaker City, we find that an arrest for homicide in Philadelphia, fifteen years ago, was of very rare occurrence (0.76 per 100,000 of inhabitants in 1890). Since that time the population of Philadelphia has increased by about 250,000, a large proportion of which augmentation has been the result of the increased immigration from southern Europe. Of the 295,340 foreigners in Philadelphia in 1900, 17,830 were born in Italy, 7,554 in Poland; 28,951 were natives of Russia, while 8,209 were born in Austria-Hungary or Bohemia; aggregating in all, from these countries, 62,544 immigrants of a much lower type, industrially and educationally, and, by inference, morally, than formerly migrated to this country. The results are shown in the records of the police courts, the ratio of arrests for homicides having increased fourfold since 1890, the annual average for the six years 1899–1904 being 4.93 per 100,000 of inhabitants.

That crimes of violence increase with the changing character of the immigrant population is shown clearly by the police statistics of the cities of Cleveland and Cincinnati. In the former city the annual average of arrests for homicide during the two years 1903–04 was 9.56 per 100,000 of population. In Cincinnati the average for the six years 1898–1904 was 6.23.[5] In 1890 the disparity was still greater, the ratio being 4.04 in Cincinnati, and 13.01 in Cleveland. The annual average

[4] 'Alien Colonies and the Children's Court,' *North American Review*, November, 1904, Vol. 179, No. 5.

[5] The average for the same period in Cleveland is not available.

of arrests for murder and manslaughter in Cincinnati during the nine years, 1880, 1890 and 1898–1904 (as shown in the foregoing table), was 5.56; for Cleveland during the three years for which statistics are available, the annual average was 10.71 per 100,000 of inhabitants. The causes of this disparity may readily be found in the relative character and proportions of their foreign population. The United States census for 1900 shows that whereas in Cincinnati 35 per cent. of the inhabitants were native-born of native parents, in Cleveland only 23 per cent. belonged to this class. In Cleveland the foreign-born formed 46.1 per cent. of the population; in Cincinnati but 17.8 per cent. were foreigners. It is also worthy of notice, in this connection, that whereas about 37 per cent. of Cleveland's foreign-born population were from southern Europe, in Cincinnati the same countries furnished only about 11 per cent. of the foreign-born inhabitants. In 1903, 13,651 immigrants settled in Cleveland; and during the same year there were 23 murders, 34 stabbing affrays, 45 shooting affrays, 56 cutting affrays, while 131 persons were assaulted. In 1904, over seven thousand immigrants arrived and settled in Cleveland, among whom were 1,464 Italians, 1,098 Hungarians, 1,637 Poles, 826 Russians, 390 Slavonians, 133 Roumanians and 30 Croatians. During this year there were 30 stabbing affrays, 51 shooting affrays, 6 murders, 91 cutting affrays, and 121 persons assaulted. As to how many of these crimes were perpetrated by foreigners is not given in the police statistics, but in his report the Chief of Police remarks that—"While the records show a large number of the arrested to be of foreign birth, it by no means follows that our foreign-born element is a criminal element, but that our city is a cosmopolitan one and our extensive manufacturing interests have drawn a large laboring class to the city." In the report of the Chief of Police of Cincinnati, the number of foreign-born among those arrested is given. The report for 1904 shows that among the 7,135 white persons arrested in Cincinnati, 4,437, or 64.04 per cent. were foreigners, though the foreign-born in that city, in 1900, formed but 18.61 per cent. of the white population. The total number of persons arrested for murder during the year was 31. In respect to other offenses, 68 were arraigned for 'cutting with intent to kill'; 49 were arrested for 'shooting with intent to kill.' There were also 146 arrests for 'cutting,' and 61 for 'shooting' a fellow man (with what 'intent' in these cases is not stated). While a large proportion of these crimes of violence were undoubtedly committed by the foreign whites, it must also be taken into consideration that Cincinnati has a large negro population, numbering, in 1900, 14,482; and that while they comprised but 4.4 per cent. of the total population, the number of negroes arrested during the year numbered 2,822, or 19.60 per cent. of the total population of the city.

In the table given above showing the ratio of arrests for homicide

in various cities, per 100,000 of population, it appears that the proportion of crimes of violence has not increased in Cincinnati during the past twenty-five years. The following figures show that they have at least increased in numbers. The police-court records show that during the twenty-one years 1884–1904, there were 335 arrests for murder in Cincinnati, an annual average of 15.95. During the ten years 1895–1904 the annual average was 17. The annual average for the four years 1901–04 was 21.

In Minneapolis, where nearly 90 per cent. of the foreign-born population are from northern Europe, and where there are neither Chinese, Italians, nor negroes, homicides are proportionately rare, the ratio of arrests for murder and manslaughter being in 1880, 2.13; and in 1904 less than one per one hundred thousand of inhabitants. In Milwaukee, where over 60 per cent. of the foreign population are Germans, the annual average ratio of arrests for homicides during the seven years 1898–1904 was 1.77 per one hundred thousand of inhabitants. This is more than twice the proportion occurring in Minneapolis; but Milwaukee has about twice the proportion of immigrants from southern Europe that Minneapolis has. In 1880, when there were comparatively few immigrants in Milwaukee from Italy, Poland, Russia or the Balkans, the ratio of arrests for homicides was 0.87 per one hundred thousand of population, and, as late as 1890, the ratio was but 0.97.

Although there is no city in the state of Kansas ranking in population with the cities here studied, for the sake of its instructive example the city of Kansas, as the largest city in the state, may be given special mention. During the two years ending October 31, 1905, the annual average of homicides (not the number of *arrests* therefor) was 17.64 per one hundred thousand of inhabitants. An inquiry addressed to Chief-of-Police Vernon J. Rose, evoked the reply that at least four fifths of these homicides were committed by the immigrant and negro population, who comprise, together, over 25 per cent. of the total population of the city. About 40 per cent. of the 9,000 employees of the six great packing houses are natives of Russia, Greece, Poland, Croatia, Bulgaria and Hungary, and Chief-of-Police Rose states that it is among these 'Bohunks' (the local term which comprehends these races as a group) that nearly all of the homicides among the whites occur.

In Providence (R. I.), where the Italians comprise more than ten per cent. of the foreign population, and where 38.1 per cent. of the total inhabitants are of foreign birth, the ratio of arrests for homicide is lower than in Boston, the annual average of arrests for homicide in Providence being, for the four years 1901–04, 1.70; and for Boston (during the two years 1904–05) 1.98 per one hundred thousand of inhabitants. But in Rhode Island, as a whole, the proportion of

population held for homicide is greater than in Massachusetts, the ratio for the former state being 0.57 per one hundred thousand of inhabitants, and for the latter 0.39. In Rhode Island the Italians comprise 11.58 per cent. of the convicts held for homicide, and but 2.09 per cent. of the total population. In Massachusetts the Italians form but 1 per cent. of the total population, and 26.1 per cent. of the convicts held for homicide.

Next to Nevada, Colorado has the highest ratio of deaths from violence of any state or territory in the continental Union. But the ratio of arrests for murder and manslaughter in her chief city, Denver, is comparatively low, the annual average ratio for the three years 1903–05 being 8.21 per one hundred thousand of inhabitants. It is a significant fact that there are but five cities of her class in the United States which have a larger proportion of native white inhabit-

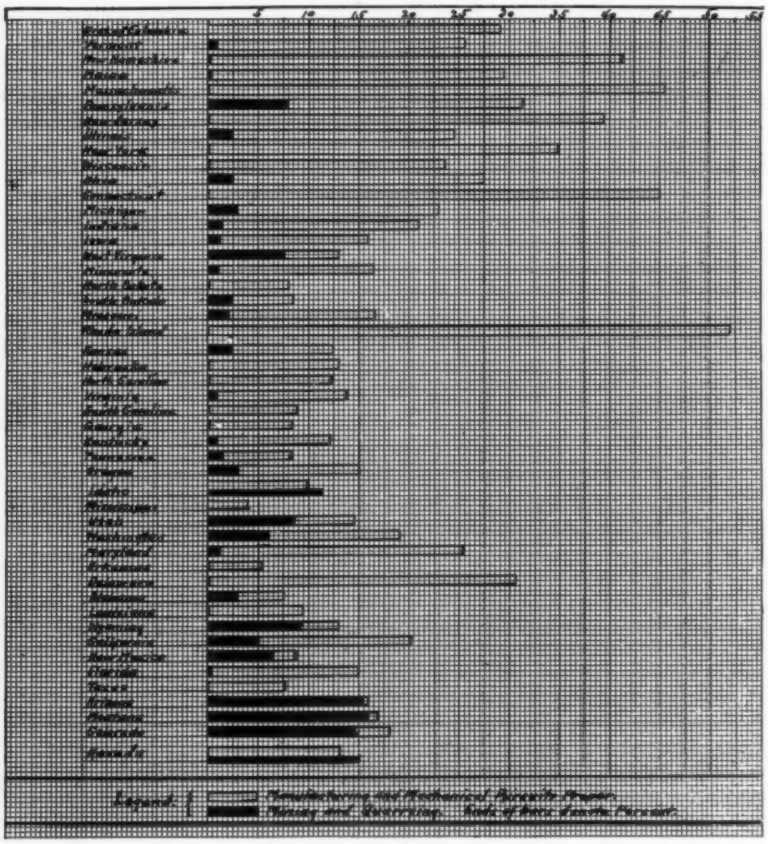

FIG. 4. PER CENT. WHICH THE TOTAL NUMBER OF PERSONS OF BOTH SEXES ENGAGED IN MANUFACTURING AND MECHANICAL PURSUITS PROPER AND IN MINING AND QUARRYING BEARS TO THE TOTAL NUMBER ENGAGED IN GAINFUL OCCUPATIONS, BY STATES AND TERRITORIES, 1900. (States and Territories are given in the order of their progressive criminality in respect to homicidal crimes.)

ants born of native parents. Only 19 per cent. of Denver's population are foreign born.

The question may well be raised: Why has the state of Colorado so high a ratio of deaths from violence (52.5 per one hundred thousand of population), and Denver so few arrests for crimes of violence? It may be replied that homicide is not naturally frequent in urban communities, but prevails in sparsely settled regions, or in mining districts. In general, homicides decrease as the proportion of persons engaged in manufacturing increases, and increase as the proportion of persons engaged in mining increases.

The figure above illustrates this principle, the states and territories being arranged according to the annual average of deaths from homicide during the decade 1890–99, the District of Columbia having the smallest number of deaths from violence, and Nevada the highest

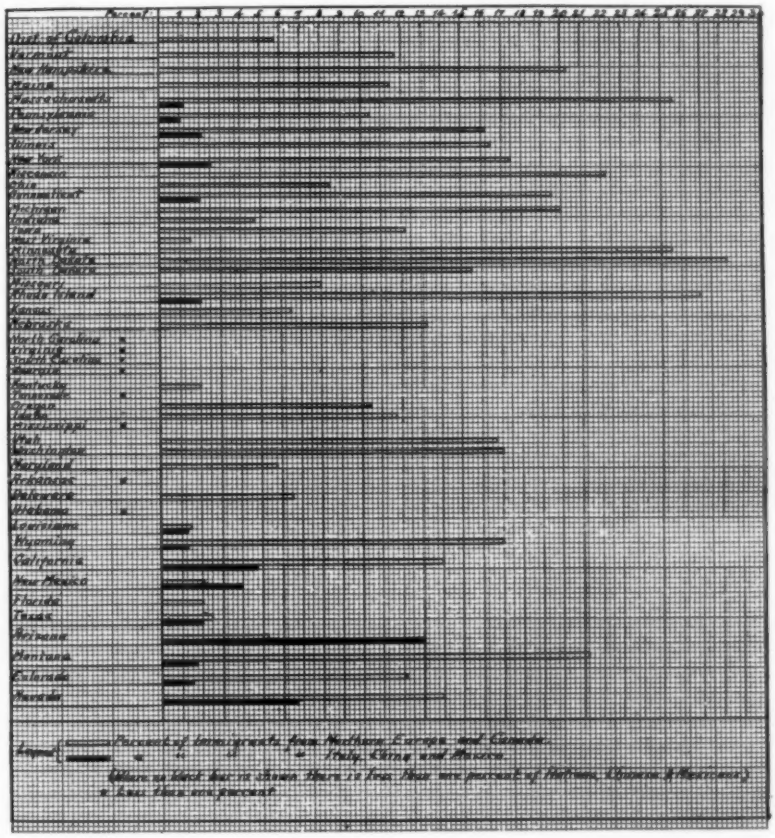

FIG. 5. SCALE SHOWING PER CENT. OF FOREIGN-BORN POPULATION (from Northern Europe, United Kingdom, Norway, Sweden, Denmark, Germany), and from the Dominion of Canada, by States and Territories, arranged according to their progressive criminality in respect to annual average homicides committed therein during the decade 1890–1899.

ratio per one hundred thousand of population. (The ratios were computed on the basis of statistics of crimes of violence compiled and published by the *Record-Herald,* of Chicago.) The white bars show the proportion of the population who, according to the United States census for 1900, were engaged in manufacturing pursuits, and the black bars indicate the percentage engaged in mining and quarrying:

It will be observed that Pennsylvania and West Virginia are the only states in the Union which are engaged extensively in mining, and yet have a comparatively low ratio of homicides. This is largely due to the fact that the mining districts in these states are adjacent to well-populated and comparatively cultured communities, whereas in the West, the mines are situated in states or territories which contain few or no large cities, and wherein the rural population is of a rather low order. Colorado, for example, has but one large city, and is one of the five most sparsely settled states or territories of the (continental) Union; whereas Pennsylvania, on the other hand, has more towns of over 4,000 population than any other state, giving it the highest per cent. of urban population of any commonwealth in the Union with the exception of New York. Again, whereas West Virginia has 38.9 persons to the square mile, Nevada has 0.4.[6]

Consistently with all that has herein been stated, we find the greater percentages of foreign-born who are most given to crimes of violence in the very states shown to produce the greater proportion of homicides, and most of which are engaged most extensively in mining, as may be seen by comparing Fig. 7 with the one preceding.

Not wishing needlessly to multiply examples and evidences, it may be said in conclusion that, however desirable the hundreds of thousands of ignorant immigrants annually landed on our shores may be from an economic standpoint, as 'much-needed laborers,' or, however charitably we may personally feel toward the hordes of hapless human beings who seek to better their condition by coming to this land of freedom and opportunities, such a vast addition of untutored and poverty-stricken people, unused to self-restraint, can not be absorbed without a material increase in crimes of violence throughout the United States, and especially in the large cities, where the recent immigration has for the greater part congested. It is to be hoped that the evidences of the Children's Court of New York City, and of police statistics in general, are symptoms rather of conditions to be remedied than of evils destined to grow more portentous.

[6] The Report of Warden C. E. Haddox, of the West Virginia State Penitentiary, for 1903–04, shows that the five counties in which mining industries predominate, with a total population of 139,812, sent 419 persons; while sixteen other counties, whose population is engaged in agriculture or other equally stable pursuits, numbering in all 205,175 persons, are represented by 28 convicts. In the mining counties one person in every 333 was sent to the penitentiary; in the sixteen counties mentioned, one in each 7,327 of population was sent to prison—a difference as great as 300 is to 13.

THE STUDY OF THE VARIABLE STARS

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THE ancient philosophers taught that the celestial bodies were 'incorruptible and eternal,' not subject to change, as are all terrestrial objects. In more recent times the stars were regarded merely as convenient points of reference for the determination of the motions of the planets. In this way they became known as the *fixed stars.* Relatively, they are indeed fixed; absolutely, all are in motion. Their light remains constant, also, for the most part, so that, if Hipparchus or Ptolemy should come back to earth after 2,000 years, he would probably notice few changes in the positions or brightness of the stars.

Any one who observes the sky carefully, through a period of years, is sure to be deeply impressed with the absence of change. Nevertheless, there are many stars which undergo more or less regular changes in brightness, and such objects are known as variable stars. In some cases the whole cycle of change takes place within a few hours, while in other cases it consumes months, or even years. The amount of the variation, also, varies enormously, ranging all the way from zero to many magnitudes, how many is not known. It is possible, even probable, that at minimum the light of some variable may, for us at least, be entirely extinguished. Mr. J. A. Parkhurst found that the variable V Delphini was invisible at its minimum of 1,900 in the forty-inch refractor of the Yerkes Observatory. This, it is estimated, would make it fainter than the seventeenth magnitude. Since its light at maximum is of about the seventh magnitude, this implies a range of at least ten magnitudes. Other stars vary as much or more. A change of ten magnitudes means that at maximum its light is 10,000 times as great as that at minimum. To illustrate this we may imagine a room illuminated by 1,000 ten-candle power electric lamps, and that these are replaced by the light of a single candle. To reduce the light of our sun by ten magnitudes would be equivalent to increasing its distance 100 times, or to more than 9,000,000,000 miles. At such a distance its apparent size would be less than the present mean size of Jupiter or Venus. Fortunately our sun, if a variable star as seems probable, has a small range of variation.

The general problem of variable stars may be divided into three parts—the discovery of the variables, the observation of all the phenomena involved, and the search for the causes. The present genera-

tion, thanks to the powerful aid of photographic methods, may hope to bring near completion the first part of the problem, and to make good progress on the two remaining portions.

The existence of a variable star was probably first recognized by Holwarda of Franeeker, in 1639. The number was slowly increased, and some knowledge of their nature learned during the next two centuries. Their observation was placed on a scientific basis through the labors of various astronomers, especially Argelander and Schönfeld. The latter astronomer issued, in 1865, a catalogue of 113 variables, and later, one of 165 variables, which included all stars then known to be variable. The list was enlarged, in 1883, at the Harvard Observatory by the addition of forty-eight variables. In 1888 Dr. S. C. Chandler published his first catalogue of variable stars, 225 in number, which had been discovered by some thirty different observers in various countries, by visual methods. Many of these observers have continued their investigations till the present time—the most successful in the line of discovery being Dr. T. D. Anderson, of Edinburgh, who by visual means alone has found forty new variables, a result truly remarkable.[1]

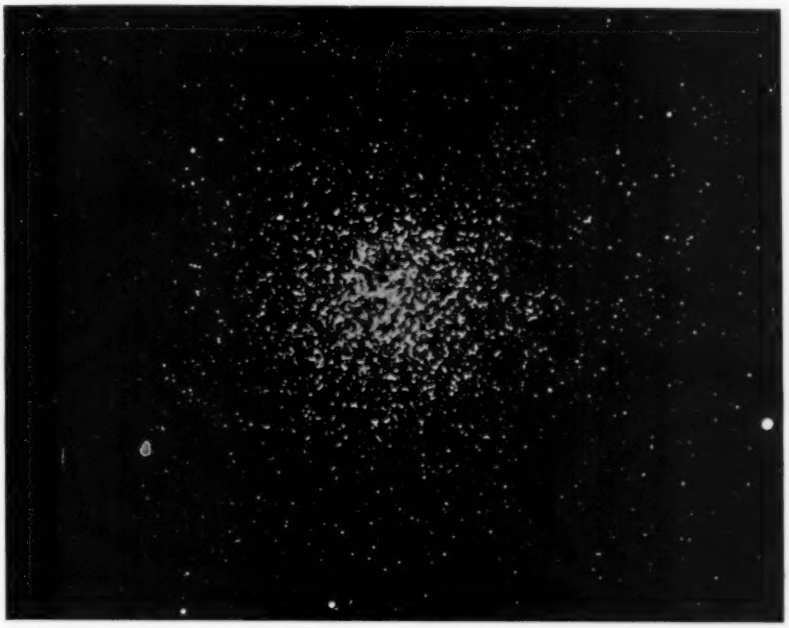
About the year 1889, however, began a rapid increase in the number of variables through the introduction of photographic methods. The first notable addition was made by Mrs. Fleming, through the examination of the photographic spectra of the stars, while engaged in the work of the Henry Draper Memorial, a research carried on at the Harvard Observatory under the direction of Professor E. C. Pickering. By means of an objective prism, placed in front of the lens of a photographic telescope of large aperture and short focal length, photographs

[1] Although the subject of variable stars is now under investigation at many observatories, there is still a wide field in this line of research for amateur astronomers. It is true the light-curves of many variables are now fairly well known, but new ones are constantly being discovered, the study of which offers an interesting field of investigation. It is necessary, in order to accomplish results of scientific value, that the observations be made, not only with enthusiasm, but with an intelligent conception of the future use to which they must be put. The observations need to include only two things, a record of the time, and the most precise determination possible of the brightness of the variable. The estimate of magnitude is usually made by referring the light of the variable to that of one or more adjacent stars, whose light is constant. For this purpose a series of adjacent comparison stars is selected, forming a sequence from bright to faint stars, and their brightness is carefully determined. It is very important that these magnitudes be reduced to the photometric scale. For identification of the stars the star charts of Father Hagen are admirable. Marked photographs are also extremely useful.

The discovery of new variables offers, perhaps, a line of work even more fascinating than the investigation of the peculiarities of those already found. Brilliant work has been done in this direction by amateurs, but at the present time much more can be accomplished by photographic than by visual means. Among those who have done work of special value, in this country, may be mentioned Chandler, H. M. Parkhurst, J. A. Parkhurst, Sawyer and Yendell. Abroad, the number of amateur observers is large.

were obtained which showed well the characteristics of scores of spectra on a single plate. Variable stars of long period were found to have spectra in which the hydrogen lines were bright, when the variables were near maximum. By taking advantage of this spectral peculiarity Mrs. Fleming has been able to 'pick up,' as a by-product of other investigations concerning stellar spectra, some 200 variables of long period.

In 1895, the writer, while engaged in photographic work at the Arequipa Station of the Harvard Observatory, began an examination of photographs of the globular clusters of stars. By the use of improved devices for controlling the motion of the telescope, satisfactory photographs were obtained of the dense globular clusters. An ex-



THE GLOBULAR CLUSTER, ω CENTAURI, CONTAINING 128 VARIABLE STARS. To the naked eye this cluster appears as a single hazy star of the fourth magnitude.

amination of these led to striking results. It was found that while certain clusters contained few or no variable stars, other similar clusters were closely packed with them. Messier 3, a faint group, barely visible as a hazy star to the naked eye, was found to contain 137 variables out of 900 stars examined, or about one in every seven stars. This is by far the greatest proportion of variables yet found anywhere in the sky. Over 500 variable stars have been found so far in dense globular clusters, and, undoubtedly, these do not entirely exhaust the number.

Madame L. Ceraski, wife of the director of the astronomical observatory of Moscow, has found a large number of variables by an examination of photographs made by M. Blajko, of the same observa-

tory. Madame Ceraski has been especially successful in finding variables of the interesting Algol type. Of sixty-seven variable stars discovered by her, no less than ten are of this class. This is remarkable when we take into consideration that of over 3,000 variables now known only thirty-eight are of the Algol type.

Through her generous gifts in aid of astronomical research, the late Miss Catherine W. Bruce, of New York, made her name widely known in astronomical circles. Dr. Max Wolf, director of the Astrophysical Observatory at Heidelberg, was presented by her with a photographic telescope, which has enabled him not only to find some seventy new asteroids, but also to increase materially the number of known

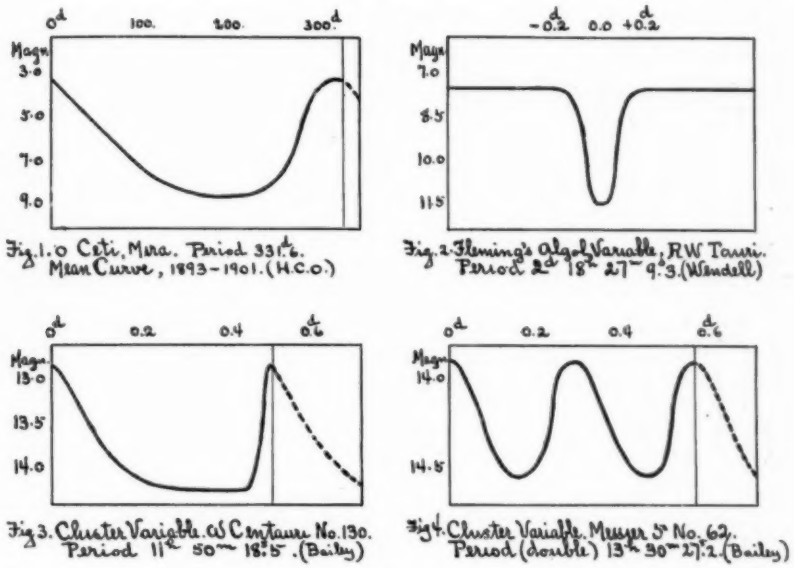
THE SMALL MAGELLANIC CLOUD IN WHICH NEARLY A THOUSAND VARIABLE STARS HAVE BEEN FOUND. To the right is the globular cluster, 47 Tucanæ, taken at Arequipa in the bruce telescope.

variables. Dr. Wolf, recently assisted by Frau G. Wolf, has discovered about 200 new variable stars.

Nowhere else, however, has so large a collection of celestial photographs been made, covering so long a period of time, as at the Harvard Observatory. In 1903, Professor Pickering instituted, among other pieces of work, an examination of the Magellanic Clouds. This work was assigned to Miss H. S. Leavitt, who has shown rare talent for this line of investigation. The regions selected were very fortunate, also, since, aside from the dense globular clusters, no other region has been found as rich in variables as the Small Cloud, although the Large Cloud also promises to yield nearly as many. It should be noted that the Magellanic Clouds are by no means merely irregular extensions of the Milky Way. They appear to be as unique in structure as in position.

Altogether Miss Leavitt has added 1,500 new variables to the already rapidly growing list.

It may be asked, why it is necessary, or even desirable, to go on indefinitely with the discovery of new variables. The answer is that, aside from the value of adding any new fact about the universe to the sum of human knowledge, the problem is now so well advanced that it seems unwise not to render the search complete for the whole sky. A serious international attempt is about to be made, for the first time, to investigate systematically all the leading problems concerned in the construction of the universe, so that a scientific cosmogony may be possible. It will be of value in this greatest of all problems to find



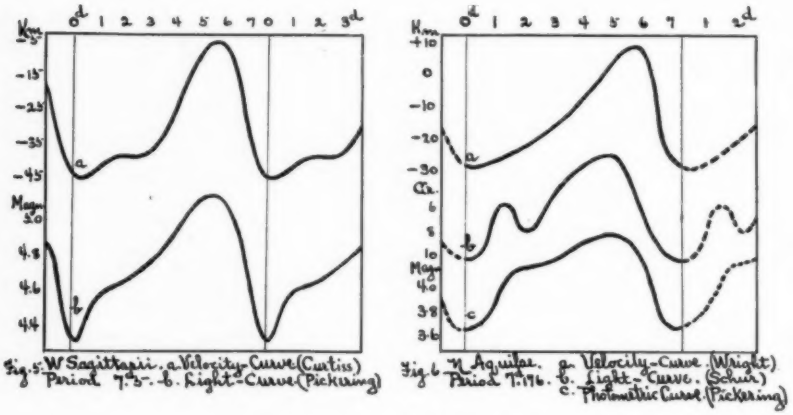
VELOCITY CURVES AND LIGHT-CURVES OF VARIABLE STARS. (The light-curves are inverted.)

the discussion of the variable stars reasonably complete for the whole sky. At the Harvard Observatory, where variable stars have been given serious attention during more than twenty years, a new catalogue, compiled by Miss Cannon, is in course of publication, which contains reference to about 1,850 variables. This does not include the variable stars in the Magellanic Clouds. Also, a committee of the *Astronomische Gesellschaft,* consisting of the well-known astronomers, Dunér, Müller, Oudermans and Hartwig, have in hand the preparation of a catalogue, which will be an extension of the former catalogues of Chandler.

The work of discovery, however arduous, is but a small part of the whole problem of the variable stars. Long series of observations are necessary, in order to learn the amount, duration and rapidity of the light-changes, or, in other words, to determine the light-curve.

Recent advances in methods of research have also made possible the study of various other phenomena, in addition to the variability in brightness. All available information will be needed to assist us in finding the true explanation of the changes. Especially must we study the spectra of these stars, and the changes in the spectra at different phases of the light-curve, as well as the motions of the stars in the line of sight. For a long time it has been known that the radial motion of any bright body may be studied from the shifting positions of the spectral lines. This principle is proving of great importance in different branches of astronomy. Only recently, however, and in few cases has this crucial method been applied to the problem of variable stars; yet it appears that the true solution of the difficulties must await, in many cases, the application of this method of research.

The determination of these different phenomena—the light-curve, the velocity-curve and the spectrum—is often carried on without special reference to the physical causes which produce them. But it



LIGHT-CURVES OF VARIABLE STARS.

will be convenient in what follows to refer to the phenomena and the probable causes together. No final classification of variable stars is possible at the present time, since such a classification would doubtless be based on the physical causes which underly the phenomena, and these are known in comparatively few cases. The division proposed by Professor Pickering, in 1881, is as convenient as any for our purposes. He placed them all in the following classes:

I. New stars.

II. Long-period variables, undergoing great variations in light.

III. Stars undergoing slight changes, according to laws as yet little understood.

IV. Short-period variables of the β Lyræ type.

V. Algol stars.

Reference will be made in what follows only to classes II., IV. and V. New stars may well be considered as a class apart. There is, possibly, no sufficient reason for including them among variable stars, technically so-called. The stars of class III. are few, doubtful, not well understood, and relatively unimportant.

II. Variable stars of long period and large variation in light are perhaps the easiest to observe and the most difficult to interpret of all. Many of them are bright enough to be observed, near maximum at least, by the naked eye, and the variations are so great that observations of the highest precision are not essential for the determination of the light-curves. The length of period ranges in general from 100

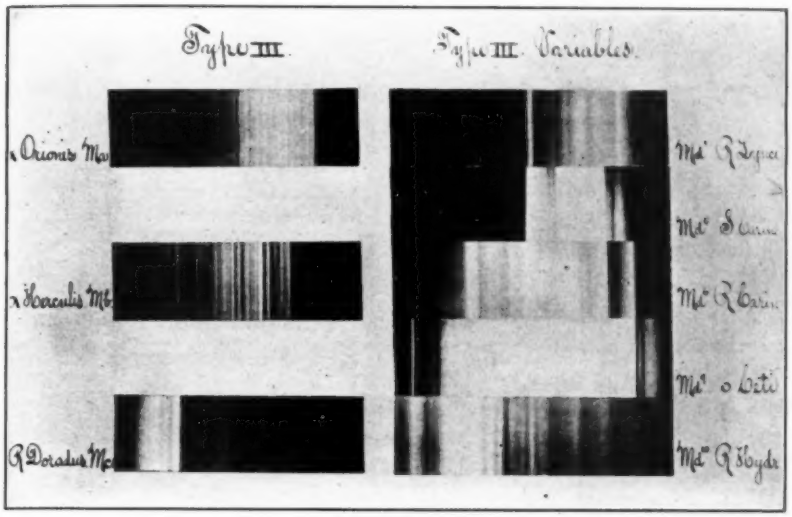


FIG. 7. STARS OF TYPE III. AND VARIABLE STARS OF TYPE III. WITH BRIGHT HYDROGEN LINES.

days to 400 days. Some of these stars have been observed by different astronomers during the last two centuries, and elaborate investigations concerning them have been made by Argelander, Schönfeld, Chandler, Pickering, and others. Omicron Ceti, or *Mira*, The Wonderful, has been studied more carefully than any other. Even here, however, much remains to be learned. The light-curve of Mira is shown in Fig. 1, and is fairly typical of the group. The variations in brightness are irregular and a single light-curve can only represent mean results. Irregularity characterizes all the phases; the exact time of any return of maximum is uncertain, and the brightness at different maxima, and at different minima, varies greatly.

The spectrum of stars of this class is in general of Secchi's third type, with heavy banded lines and flutings. A short time before maximum the bright lines of hydrogen appear, and persist till the star has grown somewhat faint again. At least, this is true of Mira, and of

some others, and is perhaps true for all. These bright lines, due to incandescent hydrogen, undergo various modifications during the time in which they are present. The relative intensity of different lines varies greatly in different stars, and also in the same star at different phases. Mrs. Fleming has been able to arrange them in a series having ten subdivisions, with R Lyncis at one end, with the H β and H γ lines prominent and H δ wanting, and R Leonis at the other end with H β wanting, H γ faint, and H δ prominent. There are also corresponding changes in the distribution of the remaining light of the spectrum, a peculiarity which is shared by stars of the same type which are not variable. These characteristics are well shown in Fig. 7.

Their great range of variation makes many of these stars invisible when near minimum in telescopes of ordinary size. This may account for the custom which has been followed by many observers of measuring the light only when the star is near maximum. This is unfortunate, since the determination of the length of the period is not sufficient in itself for the solution of the problems involved. On this account special efforts have been made at the Harvard Observatory, where the observations are carried on by Miss A. J. Cannon and Mr. Leon Campbell, to get measures of the variables at all the different phases. Even thus it is doubtful if the secrets of the changes can be found, until the research is made to include a more detailed spectroscopic study than has yet been made. A systematic study of a large number of well-selected stars is much needed. This could probably be done best by a photographic reflector of the largest size. Such a scheme of work has been proposed by Professor W. W. Campbell, director of the Lick Observatory, and from it we may expect results of the highest value. It may be well, also, to study the radial motions of these variables, but it is more than doubtful if their variability is in any way associated with orbital motion, such as would be found in binary systems. The irregularity in the recurrence of the phenomena seems to preclude the possibility of such an explanation. The stars of this class probably contain within themselves the causes of their changes. They are, perhaps, at that critical stage of development where occasional internal disturbances cause tremendous outbursts, especially of incandescent hydrogen, resulting in an enormous increase of light. The commotion slowly dies down only to return again with more or less of regularity. For the details of these disturbances we must await further study.

IV. Of the 3,000 variables known at present probably the vast majority have short periods, that is, periods of a few days, or a few hours. The periods, also, are uniform; or, at least, if apparent irregularity exists at times, this is capable of being expressed by rigorous mathematical formulæ. η Aquilæ and β Lyræ are well-known examples of this class. Recent investigations have shown that such stars are binary systems, and that in some way the light phenomena are as-

sociated with orbital revolution. Belopolsky, and later Campbell and Wright have investigated the velocity-curve of η Aquilæ. From their investigations it appears that this variable is a binary, whose period of revolution is of the same duration as the period of the light-changes. The determination of the velocity-curve is accomplished by the use of a slit-spectroscope, which gives a comparison spectrum of some known element, which is also present in the spectrum of the star. Since the velocity-curve and light-curve are synchronous it might be suspected that the light variation was caused by an eclipse of the star by a relatively dark companion. This can not be true, however, in the case of η Aquilæ, for various reasons. In the first place, the light-curve is not that of an eclipsing star. An eclipse must occur when two stars are both in the line of sight, at which time the apparent motion would be small or zero. As a fact, the minimum of the star does not occur at such a time. The light maximum occurs noticeably later, and the minimum noticeably earlier than the periastron of the star. These facts seem not inconsistent with the theory that the variations in lights are caused by the close approach of the components of a double star moving in elliptical orbits, the outburst of light resulting from some tidal disturbance incited by the enormously increased mutual attractions of the two bodies. An objection to this explanation is that under these circumstances the outburst would probably manifest itself by the presence of bright lines in the spectrum at maximum, as is the case with long-period variables. Small evidence exists that this is true. Another difficulty is found by a comparison of the curves of velocity and light, as determined by Wright and Schur. The former is a smooth curve, while the latter has a secondary maximum. That this may be due in part to an error in the form of the light-curve as given by Schur, seems not impossible, if we compare it with the light-curve of the same star as determined by Pickering with a polarizing photometer. The latter curve shows merely an indication of a secondary maximum. It may be true, of course, that the secondary maximum is sometimes present, at other times absent. That the relation between the curves of motion and light may be most intimate, in some cases at least, is beautifully shown by the variable ω Sagittarii. The velocity-curve of this star was determined by Dr. Curtiss, of the Lick Observatory. As pointed out by him, the velocity-curve, and the light-curve determined by Professor Pickering, show a close resemblance even in the details, which proves conclusively that both phenomena are associated with the same underlying causes. Incidentally, a striking proof is furnished of the accuracy of these two widely separated investigations, thus critically compared. These curves are shown in Fig. 5.

β Lyræ represents a somewhat different variety of the short-period variable. This star has been studied for more than a century and still remains something of a mystery. The spectrum is complex, the lines

showing displacement, apparently due to the motions of the bright components of a close binary. These displacements were explained in 1891 by Pickering as the result of the revolution of the unlike components of a binary system, having a relative velocity of 300 miles per second, and a radius of 50,000,000 miles. Belopolsky has also investigated this object, obtaining results which differ somewhat from those given above. Professor G. W. Myers has made a mathematical discussion of the problem, reaching the conclusion that the phenomena can be explained on the theory of a binary system, composed of two gaseous, scarcely separated, components of different masses, mutually eclipsing each other during their revolutions. Indeed the two components may not have separated, but exist still as a single body of unusual form, such as Poincaré's, or Darwin's figures of equilibrium. The problem is extremely complicated, and well illustrates the almost infinite diversity which is met with in the various problems about variable stars. The binary character of this type of variables seems sure in many cases, while in others even three bodies appear to be present; but the details involved are still in doubt.

The variable stars found in clusters have periods ranging for the most part from ten to fourteen hours. The elements of about 300 of them have been determined by the writer. The uniformity of the periods found in the same cluster is remarkable, pointing unmistakably to a common cause. What that cause is has not yet been found. The form of light-curve is shown in Figs. 3 and 4. Owing to the faintness of these stars, which generally vary between the twelfth and fifteenth magnitudes, it has not yet been possible to determine either the nature of the spectrum or the radial motion. The light-curve shows no indication of eclipsing phenomena. The uniformity in the period, traced in many cases through more than 5,000 returns of maximum, points to axial rotation or orbital revolution. Variability might result, undoubtedly, from the rotation of an elliptical, or unevenly luminous body; but the light-curves of cluster variables are difficult of explanation on this theory. They may be binaries with small, elliptical orbits, but even this is hardly consistent with the form of light-curve. The rejection of these hypotheses, nevertheless, seems to leave the phenomena without plausible explanation. A few cluster variables have been found where the maxima succeed each other at intervals of about six hours, one half the usual period. This indicates pretty clearly a double variable with alternating maxima, both components having the same period. These apparently accidental cases of duplicity may throw some light on the physical condition of all these stars.

V. Of the Algol variables Algol itself is a good example. Its light usually remains at a uniform brightness of the second magnitude, but once in a little less than three days it falls to the third magnitude, where it remains for some twenty minutes before beginning to regain

its brightness. The whole time for the decrease and the restoration of light is about ten hours. The form of this light-curve points unmistakably to the eclipse of a bright star by a relatively dark companion. This explanation, first proposed by Goodricke, was developed by Pickering, and proved spectroscopically by Vogel. Dr. Alexander W. Roberts, of Lovedale, South Africa, has recently developed a method for determining the absolute dimensions of an Algol binary. The theory which underlies the determination is that light takes an appreciable interval of time to traverse the orbit of a binary system. For an accurate solution observations of the highest precision are essential. Precise photometric observations of such objects have been made by Professor O. C. Wendell, of the Harvard Observatory. The cause of variation is in general the same for all the Algol variables, though there are minor differences of importance. As might be expected, they show great regularity. Nevertheless, there are certain secular variations from causes not well understood. The period of Algol is believed to vary slightly, and Dr. Chandler explains this as due to the presence of a third body. M. Tisserand, however, has advanced a different theory. He assumes a slight flattening of the globe of Algol, and an elliptical orbit for the companion. These rival theories can be settled only by elaborate determinations of the light-curve during many years. According to Dr. Chase, Algol is at a distance of ninety-three light-years. Vogel finds the diameter of each of the components to be nearly a million miles, and the distance between them little more than three million miles. There are doubtless thousands of binary systems in the heavens, one component of which is more or less obscure. Such a system, and it holds true even if the components are equally luminous, becomes for us an Algol variable when the plane of revolution passes through or near the earth. Such systems are comparatively rare. At the present time only thirty-eight are known. The largest variation yet found is that of Fleming's Algol, R. W. Tauri, whose light at minimum is only one twenty-sixth as great as its usual amount. It would be possible for a dark companion of the same size as the bright component to completely eclipse it. In the case of υ Cephei, indeed, this probably takes place, so that the light while the eclipse lasts comes entirely from the dark companion. The companion is only relatively dark, however, so that its light alone is about one eighth as great as the combined light of both components. If the companion, in such a case, were completely obscure, there would be a total eclipse of the star's light, but no such case has yet been found.

THE CAMPUS OF CORNELL UNIVERSITY, WITH CAYUGA LAKE IN THE DISTANCE.

THE PROGRESS OF SCIENCE

CORNELL UNIVERSITY AND THE SUMMER MEETING OF THE AMERICAN ASSOCIATION.

WHEN the American Association for the Advancement of Science decided to hold a special summer session between the winter meetings in New Orleans and New York City, it was well advised in choosing Ithaca as the place. There is probably no other university in the world with such a beautiful site and surroundings, and there are but few institutions whose buildings, equipment and work are of greater interest to students of science. Ithaca is not far from the center of scientific population, and Cornell is in many ways intermediate between the eastern private foundations, such as Harvard, Yale and Columbia, and the state institutions of the central west, such as Michigan, Illinois and Wisconsin.

Cornell owed its origin to state support combined with the generosity of the man whose name it perpetuates. One of the most beneficent acts of congress, notable for its wisdom and because it was proposed in the midst of the civil war, was the land grant for the establishment in each state of a college primarily for agriculture and the mechanic arts. The act, approved July 2, 1862, provided that there should be granted to the several states public lands, thirty thousand acres for each senator and representative of congress, from the sale of which there should be established a perpetual fund "the interest of which shall be inviolably appropriated, by each state which may take and claim the benefit of this act, to the endowment, support and maintenance of at least one college, where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

New York state received about a million acres, and, thanks largely to the wisdom of Mr. Ezra Cornell, most of the land was held until ultimately it yielded over five million dollars. In accordance with Mr. Cornell's well-known words, 'I would found an institution where any person can find instruction in any study,' Cornell University was established in 1865 and opened in the autumn of 1868. Thanks to the wise administration of Dr. Andrew D. White, to a loyal group of able teachers and men of science, to state support and private beneficence, Cornell has become one of the great universities of the country and of the world, fulfilling as nearly as may be the dreams of its founder. There are now some five hundred officers and four thousand students divided among departments as follows: the graduate department, the college of arts and sciences, the college of law, the medical college, the New York state veterinary college, the college of agriculture, the college of architecture, the college of civil engineering, the Sibley college of mechanical engineering and mechanic arts.

At Cornell University a gathering of scientific men could not be other than pleasant and profitable. There were in all about 400 in attendance at the meet-

ings which were held from June 27 to July 3. This is as large a group as is necessary or even desirable for the enjoyment of those who are present. It might, however, have been expected that a larger number would have taken advantage of the opportunity. The chemists, physicists and others who held technical meetings came in fair numbers, but there were not many who attended the meeting in order to see the university and the surrounding regions, to meet their colleagues in other departments and learn of the general forward movement in science, or to do their share in promoting the organization of scientific work and scientific men. Thus sections A and K held no meetings at Ithaca; the special societies whose subjects were included in those sections—mathematics, astronomy, physiology, anatomy, pathology, psychology, etc., did not hold meetings, and the registration in those sections was four members. The absence of those who are not professional students of science was also noticeable and probably regrettable. It should be one of the functions of the association to keep science in touch with the larger public and to increase scientific interest throughout the country. It was hoped that the resumption of summer meetings would be a step in this direction, but it does not seem that very much was accomplished at Ithaca.

Yet the character of the meeting, as well as its place, was as attractive as could well be. Dr. Welch, our leading pathologist, was an admirable presiding officer and gave two interesting addresses. Two addresses were given by President Schurman and one by Dr. Andrew D. White. The evening lectures, by Professor Carhart on the South African meeting of the British Association and by Professor Branner on the California earthquake, were particularly timely and interesting. The new physical laboratory of the university was dedicated, and Sigma Xi celebrated the twentieth anniversary of its foundation. The excursions arranged by the

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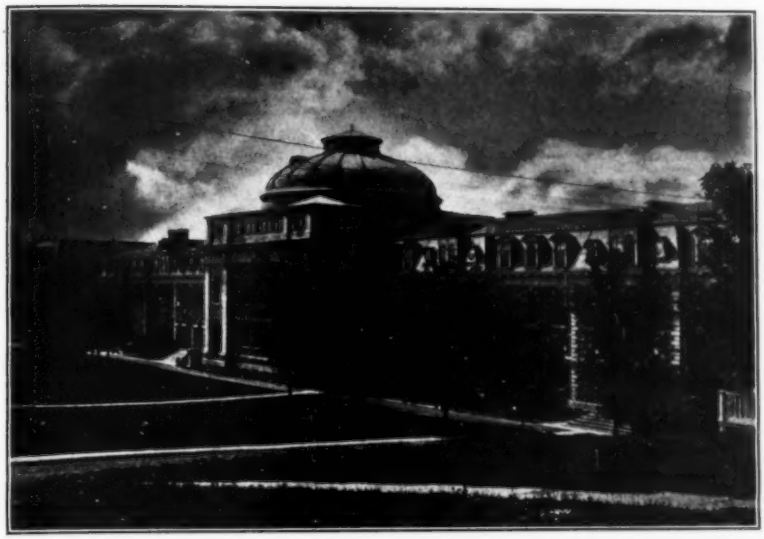
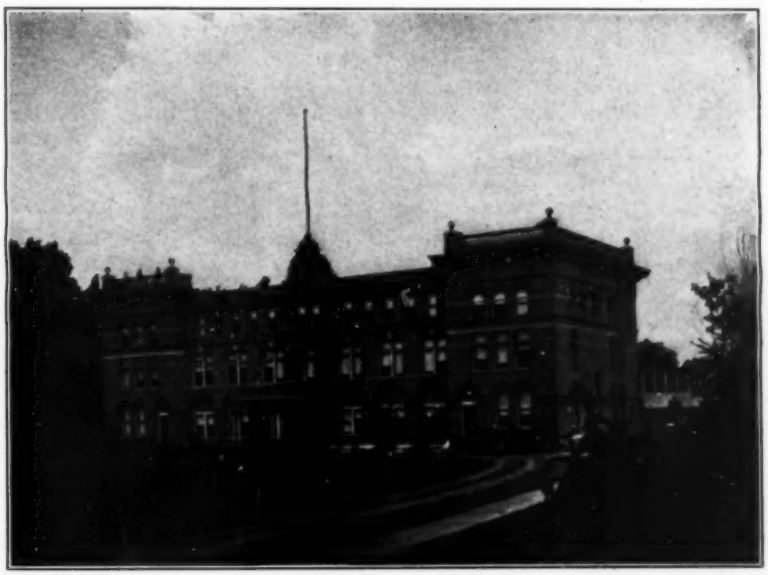
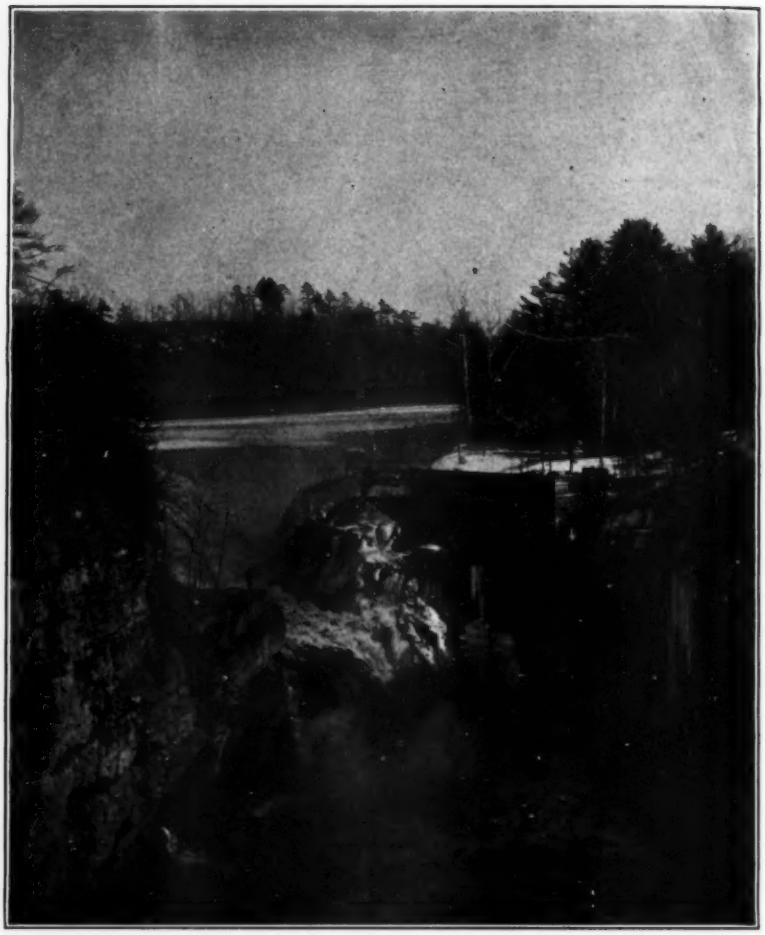


SIBLEY COLLEGE OF MECHANICAL ENGINEERING.

geologists, botanists, chemists, engineers and economists were in every way successful. Thus apart from the more special scientific programs, which in several subjects were very good, there was much to attract all who are interested in science, and those who were present will remember the Ithaca meeting as one of the most pleasant in the history of the association.



THE STATE VETERINARY COLLEGE.



BEEBE LAKE AND TRIPHAMMER FALLS ON THE EDGE OF THE CORNELL CAMPUS.

LEGISLATION AND SCIENCE

GOVERNMENT is becoming more and more an application of science. Politics are still largely a game and a trade; the kind of science at hand is crude and is applied by the rule of thumb. But if the proceedings of successive parliaments or congresses are reviewed, there is an evident tendency for legislation to rest increasingly on expert knowledge and to require continually greater scientific skill in its execution. When the constitution of the United States was written, the threefold division of the functions of the government—legislative, executive and judicial — was adequate. Now, however, it may be urged that the scientific or expert functions are coordinate with the others. Laws may be made by the congress, interpreted by the courts and executed by the president, but they should be based on scientific investigations and carried out by scientific experts.

We are told that municipal government should be divorced from politics, and this is doubtless true. A municipality is primarily a business or engineering corporation. Its main concern

is with streets, sewers, parks and docks; with schools, hospitals and public institutions; with water, light and the means of transportation and communication. But there are equally sound reasons for keeping the government of a state or nation free from politics and conducting its affairs with such skill and efficiency as are attainable. There are certain questions that are quite outside the limits of such science as we now have, for example, the desirability of more or less centralization, paternalism, aristocracy, war or religion. The people may legitimately divide themselves into parties on such lines. Science may be unable to answer the question as to whether the government should conduct the postoffice, the express business or the railways, but when the government has undertaken to manage the mails, it makes no more difference whether the postmaster general is a republican or a democrat, than whether he is a catholic or a protestant, married or single. It would be well if we could separate those questions which must for the present be settled by party government from those which should be decided by expert knowledge, and if the latter could be settled by men having the necessary special training. And of course nearly all the executive work of the government should be done by experts, and a large part by those who are technically men of science.

The main questions before the first session of the fifty-ninth congress were concerned with the extension of federal control by the regulation of interstate commerce, and may be regarded as outside the scope of this journal. But the decisions of the congress rested, or should have rested, on statistical or other scientific data. In the execution of the laws relating to railway rates, meat inspection and pure food, a large number of trained scientific men will be required. The removal of the tax on alcohol which has been 'denatured' will have an important effect on the arts. While we should like to see the decimal system of weights and measures or even a duodecimal system made compulsory, it must be admitted that technical opinion is so divided that the house can scarcely be blamed for rejecting the measure. Of direct scientific interest were the bills protecting Niagara Falls, the Mariposa trees of California and the antiquities on the public lands. Although the main increase in the appropriation for the Department of Agriculture was for meat inspection, its scientific work was enlarged in several directions. The appropriation for rebuilding the Military Academy at West Point was increased to $6,500,000. A lock canal at Panama carried to the height of eighty-five feet was decided on, and the sum of $42,500,000 was appropriated for the work.

SCIENTIFIC ITEMS.

We record with regret the deaths of Dr. Henry A. Ward, president of Ward's Natural History Establishment at Rochester, and Dr. Fritz Schaudinn, recently appointed head of the parasitological department of the Institute for Tropical Diseases of Hamburg and well known for his work on the protozoa.

The Ordre pour le Mérite has been conferred on Professor Robert Koch by the German Emperor.—Dr. Ernst Mach, of Vienna, has been awarded the Bavarian Maximilian order for science and art.—Professor Simon Newcomb has been elected a member of the board of overseers of Harvard College.—The Society of Arts has awarded its Albert medal to Sir Joseph W. Swan, F.R.S., 'for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing.'

Announcement has been made of the resignation of Dr. William T. Harris, commissioner of education, and of the nomination of his successor,

Professor Elmer E. Brown, of the University of California. Dr. Harris's retirement has been made possible by a retiring allowance from the Carnegie Foundation for the Advancement of Teaching. This action was taken by the trustees of the foundation under one of their rules which permits of such action in the case of extraordinary and unusual service to education. Dr. Harris has been the commissioner of education since 1889, and has, perhaps, had a larger and more intimate connection with the whole body of teachers than any other man. The offer to him of this retiring allowance was an act of the highest regard for his work and places his name at the head of the list of distinguished men who have accepted such retiring allowances from the Carnegie Foundation.—Dr. D. E. Salmon, from 1884 to 1905 chief of the Bureau of Animal Industry, has accepted the offer of the government of Uruguay to organize a Bureau of Animal Industry for that country. Dr. Salmon, who is at present engaged in scientific work in Montana, will start for South America about December 1.

THE protocol providing for the establishment of an international institute of agriculture at Rome, Italy, has been adopted by the congress. There are about forty governments party to the arrangement. Studies will be made of all kinds of plant life and means of extermination of insects and other pests. The institute will receive the reports of the agricultural bureaus and societies of all countries. The Italian government will supply the buildings, and the cost to other governments will be about $5,000 a year each.